

2018

Ground Truthing: The Politics And Culture Of Soil And Water Conservation In Iowa Agriculture

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GROUND TRUTHING:
THE POLITICS AND CULTURE OF SOIL AND WATER CONSERVATION IN
IOWA AGRICULTURE

by

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For the Degree of Doctor of Philosophy in

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2018

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ACKNOWLEDGMENTS

I am so full of gratitude.

To the entire Department of Anthropology at USC, faculty, fellow graduate students past and present, and staff, you have encouraged me from the beginning with your enthusiastic support. And to Cat Keegan, I cannot imagine making it through this experience without your couch, your reality checks, and your warm humor and friendship. I miss you sorely and think of you with every frog I see.

To my committee, Jessica Barnes, Courtney Lewis, and Terrance Weik, what an opportunity to have a team of wonderful scholars guiding my work from the beginning. And to my chair, Jennifer Reynolds, working with you has made me a better anthropologist. This work would not be as rich without the breadth and depth of your knowledge and feedback.

To my loved ones—who made me feel capable despite my uncertainty and doubt—including but not limited to: My graduate cohort. My HEAT Ethnographic Field School of 2013. My Columbia community, especially Girls Rock Columbia. Ya'll ground and inspire me. To Andrea Warren, Tiffany Jones, and Kelsey Hanrahan, for their company and invaluable insights as I wrote. To all of my friends who reminded me that breaks and joy (i.e. ice cream and sunshine) are necessary conditions for good work, particularly Cecile Lomer, Amy Mills, Leland Ferguson, Sarah Friedrich, Hartley Middleton, Alison Salisbury, Becca Shepherd, and Bach Pham.

To Katie Stanzilis for your patient kindness in the midst of the most intense period of my graduate career. To Andrea Rissing for believing in the value of working in Iowa and your meticulous aid in making this dissertation happen. To Suzanne Vargas for reminding me of my own brilliance. To Joanna Casey for your incredible friendship and generosity. To Kelly Goldberg who shared this whole doctoral ride with steadfast hilarity. To Suzan Erem and Paul Durrenberger, I will honor your gifts of mentorship, home, and hope for a brighter future by sharing in your work toward connection and justice. And most of all, to my wonderful parents Mark and Jill and my brother Kevin for their endless support as I pursued this tricky dream of being an anthropologist. I did not always feel certain about this dream, but you always believed in me.

And to all of the Iowans who granted me the privilege of sharing in your work and lives, I have learned so much being able to do this research with you, and in this dissertation I share some of the many stories that moved me. With your help, I too believe in the beauty and possibility of Iowa. I am deeply thankful for the prairie walks, the tractor rides, the good food, the tours, and all of the time spent opening up your home and state to me. For the sake of anonymity, I will not name the many people who housed, fed, and inspired me with conversation and connections. Nevertheless, you all (ya'll) have made this work possible.

ABSTRACT

This dissertation explores the complex relationships between people, technologies, and ecologies involved in natural resource conservation and industrial agriculture in Iowa. Specifically I focus on the various efforts to address water pollution affected primarily by agriculture in the state. Using a theoretical framework informed by political ecology, Science and Technology Studies (STS), and posthumanist theory, I draw on thirteen months of ethnographic fieldwork to discuss what makes conservation culturally salient and practically difficult to achieve. This difficulty around conservation arises in part from the tensions between what I describe as the corn assemblage and the prairie assemblage. I identify these assemblages as analytically useful categories due to the synergy of similar desires and practices of various actors in the Iowa landscape. The idea of separate but co-constituting assemblages clarified as Iowans debated the efficacy of regulatory versus voluntary approaches to conservation goals. This debate intensified in large part due to a lawsuit begun by Des Moines Water Works, the state capital's drinking water utility, that cited agricultural drainage systems as sources of pollution. The lawsuit followed the collaboration around the state-led Nutrient Reduction Strategy, designed to recommend practices that reduce nitrogen and phosphorous into local waterways.

The people, ecologies, and technologies comprising the corn and prairie assemblages work for and toward the idea of conservation (i.e. a boundary object), the

vagueness of which allows individuals and groups with different motivations to work together without consensus. Although the desires of the corn assemblage and the prairie assemblage—farm continuity and landscape revitalization respectively—are often depicted as at odds with each other, certain actors in Iowa worked to bridge these desires to create a more lively and livable landscape. I discuss the tensions and collaborations on the landscape through ethnographic and material descriptions of scale-making through watersheds and farm acreages as well as corn and soybean agriculture, waterways and drainage tile, and the conservation practice of planting cover crops. I also discuss how variation occurred with corn agriculture and simplification occurred within natural resource conservation in order to question traditional depictions of industrial agriculture and conservation work. Then I discuss how farmers and conservation experts—as actors within my assemblage analytic—positioned themselves in relationship to voluntary and regulatory approaches to the conservation boundary object and their particular desires for the Iowa landscape.

However, the circulation of (scientific) knowledge by local news media and farm advocacy sources complicated conservation work, as actors within and between the assemblages negotiated blame, accountability, and ultimately, responsibility for environmental degradation. I demonstrate this negotiation through an analysis of media sources' two diverging narratives of the natural nitrogen cycle, one which located the rich, fertile Iowa soils as the polluter and the other narrative which focused on human activity, or the absence of year round and active plant roots. Many Iowans dismissed and obscured the role of science and scientific knowledge in everyday and state-level politics, instead insisting their knowledge was neutral and unbiased. Obscuring the political

consequences of science contributed to the limited efficacy of efforts among actors in the prairie assemblage to bridge landscape revitalization and farm continuity. Strategies like promotion of soil health, collecting water quality data, and developing technology for conservation all operate on the premise that knowledge empowers changes in behavior and action, while my research suggested farmers and landowners felt overburdened with information and were therefore selective in their consumption of circulating information. I conclude that multiple actors and groups—in farming and natural resource conservation—maintain and sustain the current industrial agricultural system, which contributes to ecological and social degradation, through extensive material and ideological work. However, this system requires so much work that has been naturalized but still has failures and gaps. I end with a consideration of how Iowans and I imagined the future of Iowa's landscape as well as why approaching Iowa relationally and complexly matters.

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LIST OF ABBREVIATIONS

CRP	Conservation Reserve Program
CSR.....	Corn Suitability Rating
DMWW	Des Moines Water Works
EPA.....	Environmental Protection Agency
HEL.....	Highly Erodible Land
HUC	Hydrological Unit Code
ICGA.....	Iowa Corn Growers Association
IDALS.....	Iowa Department of Agriculture and Land Stewardship
IDNR.....	Iowa Department of Natural Resources
IFBF	Iowa Farm Bureau Federation
ISA	Iowa Soybean Association
ISU	Iowa State University
NRS.....	Nutrient Reduction Strategy
NRCS	Natural Resources Conservation Service
ppm	parts per million
SWCD.....	Soil and Water Conservation District
WMA	Watershed Management Authority
WQI.....	Water Quality Improvement

CHAPTER 1

GROUNDED TRUTHS

“Why Iowa?”

This question haunted me throughout my fieldwork. It was not a bad haunt necessarily. The question also grounded me, asking me to remember how I ended up here and what I hoped to accomplish. It came from multiple directions—research participants, academic mentors, loved ones, myself—coalescing in me driving on straight, empty two lanes surrounded by cornstalks, walking through prairie, dipping buckets into creeks and rivers. Out of all the places an anthropologist interested in the environment and agriculture could go, why did I choose Iowa?

A colleague’s mentor told her that he picked his research topic because it made him uncomfortable. Anthropologists have refined the feeling of discomfort into methodologies like ethnography and participant observation. Constantly, we put ourselves in positions as cultural amateurs and strangers in order to learn how other people perceive and participate in the world. Data collection and analysis involves using reflexive techniques to examine ourselves and our relationships as researchers, allowing vulnerability to enter our expertise. Even if the field site and research participants are familiar to an anthropologist, our methodologies make it strange for us and the people who know us, or expect us to know, their lives. The anthropological epistemology is then

to know by first not knowing on a profound level. I sifted through the multiple issues that made me both curious and uncomfortable (plenty of anxieties worthy of anthropological dreaming), and landed on industrialized commodity crop agriculture, and its depiction in popular and academic literature.

For most of my graduate career, the world of multispecies ethnography has enthralled me. It satisfied the latent biologist within me as well as my increasing scholarly interest in the interactions between humans and nonhumans. Anthropologists and researchers using multispecies ethnography identified and depicted close, intimate relationships between humans and nonhumans, often in indigenous cultures, that broke down the nature-society divide (Ingold 2012; Kohn 2007, 2013, Nadasdy 2007; Viveiros de Castro 1998; Willerslev 2007). These scholars articulated a fascinating, beautiful merged and merging ontology—the study of being and becoming, existence and reality—and epistemology—the study of knowledge, specifically how we know and how we determine truth. Indigenous worldviews and multispecies analyses provide one domain of evidence that being in the world and knowing about this world are not dichotomous. Knowledge resides in bodies and practices, and embodied practices contribute to what is known. Ontology and epistemology need each other in order to make sense.

It troubled my curiosity that no scholar described this explicit, conscious ontological-epistemological merging within a society I recognized as my own. While technology and industrialization no longer seemed to represent unadulterated evil but held a more ambivalent status requiring critical analyses, thanks to feminist science studies in particular, I rarely had the sense that knowing and being came together within technology-dependent, industrialized societies. Did industrialization and capitalism

preclude this kind of embodied knowledge? Had technology and commodification separated us from knowing our environment? If I could find evidence of embodied environmental knowledge existing within industrialized capitalist systems, I thought one of the best places to look would be agriculture. Cross-culturally, farmers display intimate knowledge of landscapes, seasons, crops, and interspecies relationships (Arce and Fisher 2007). I had experienced it myself by volunteering on small-scale diversified farms. My knowledge of environmental workings and connections expanded through the embodied knowledge shared with me from farmer friends. I saw this reflected in academic literature as well. However, as soon as machinery and capital were part of the system, environmental relationships were deemphasized to almost nonexistence, and victims of/participants in capitalist greed were the primary depictions of people in industrial agriculture. I wanted to understand what environmental relationships looked like within these conditions.

This curiosity coincided at the same time a soil scientist told me, “Bri, if we could just get farmers in the Midwest to plant cover crops, we could reverse the dead zone.”¹ With this provocative claim, I had industrial agriculture implicated in an environmental problem—water pollution—and examples of people and groups working to change that. With my car packed and set due north, I headed to a fieldsite ripe and rife with complicated naturecultures (Haraway 2008).

¹ Cover crops are planted in between commodity crops to protect the soil, and the dead zone mentioned here is a large area of the Gulf of Mexico that loses oxygen, becoming “dead,” every summer.

1.1 Background

When I arrived in August 2015, two years previous—at the behest of the Environmental Protection Agency (EPA)—Iowa State University (ISU), Iowa Department of Natural Resources (IDNR), and the Iowa Department of Agriculture and Land Stewardships (IDALS) circulated a document, the Nutrient Reduction Strategy (NRS), which provides guidelines for how to reduce the load of nitrogen, phosphorous, and sediment into the Mississippi River, which eventually ends up in the Gulf of Mexico and creates the seasonal hypoxic or “dead” zone. For two years, mainly through literature reviews, teams of scientists had examined the best implementation practices for farmers, industrial plants, and cities and towns to reach the lofty goals of a 45% reduction in nitrogen and phosphorous delivery to waterways. These practices were directed primarily at nonpoint source pollution, requiring a 41% reduction in nitrogen and 29% reduction in phosphorous (IDALS, IDNR, and ISU 2013). Nonpoint source pollution is not regulated under the Clean Water Act of 1972, and water from agricultural fields has been labeled nonpoint source pollution. The water from agricultural fields is considered too diffuse to locate and regulate, unlike a pipe from a factory. The state of Iowa is mainly in agricultural production at 30.5 million acres (USDA NASS 2017) so the nonpoint source pollution section has received much of the public attention.

The over 200-page document has been whittled down to two glossy pages of practices, showing the percentage reduction expected based on the studies the nonpoint source pollution team evaluated (see Figure 3.15). In public discourse, people call this suite of practices “the toolbox” or “silver buckshot.” These metaphors emphasize that no one practice on the list is the solution for nutrient reduction and environmental conservation, although several practices—such as cover crops—are lauded as the most

beneficial and effective, depending on the intended goals. These metaphors also suggest personal choice, which underlies one of the most intense debates in Iowa. Should conservation practices be compulsory or voluntary, and how does each system of participation work?

In the Chesapeake Bay, anthropologists have worked with farmers responding to nutrient reduction under a regulatory framework (Paolisso and Maloney 2000; Paolisso et al. 2013). The researchers' goal was to define farmers' environmentalism, and how it might coincide with activists' environmentalism and conservation in the future. These farmers discussed how farmland provided open space—like “pristine” nature would—and necessities like food, conveying a utilitarian view of their landscape but also aligning this view with conservation goals. In their case, the connection between nutrient runoff and toxic conditions in the Bay caused by dinoflagellates was not well understood scientifically, making their regulatory framework, dismissal as local experts, and portrayal as polluters frustrating. On the other hand, since 1997, the Mississippi River Basin states—of which Iowa is one—have partnered with the Environmental Protection Agency (EPA) to address nutrient issues through a voluntary approach. Many states have implemented a variety of voluntary and semi-regulatory strategies to address water pollution. For example, Shoreman and Haenn (2009) discussed Mississippi Delta farmers' use of potent anti-regulation rhetoric to organize conservation efforts extremely successfully. In the case of Iowa, most farmers and many natural resource professionals I spoke with used anti-regulation rhetoric, yet the same organizing power to successfully implement conservation practices did not occur as it did in the Delta. In Iowa, the question of regulation versus voluntary participation has been and continues to be messy;

neither solution seems capable of bringing about the change scholars call necessary (Comito et al. 2012; Roberts and Lighthall 1991). This dissertation explores the political, scientific, and emotional facets that make conservation culturally salient and practically difficult to achieve in Iowa.

The Nutrient Reduction Strategy links Iowa to Gulf Coast states and landscapes via the delivery of nutrients. Nutrient sounds innocuous at worst and beneficial at best. In Iowa, nutrients help crops grow and are therefore essential. In excess, however, nutrients cause health problems, for the environment, nonhumans, and humans. The hypoxic or “dead zone” in the northern Gulf of New Mexico has mobilized action from the EPA and Mississippi basin states over the last 20 years. Hypoxia means lack of oxygen, which results from a bacterial-algal interaction. With an influx of nutrients carried down the Mississippi, algae in the Gulf bloom prolifically. Bacteria then consume the algae, and their consumption uses up most of the available oxygen in the water. Anything else requiring oxygen—fish, sea mammals, plankton, aquatic plants—cannot survive. Hypoxia happens naturally, but human activity in the Gulf has exacerbated this summertime marine graveyard.

However, it was not the dead zone that held Iowans’ attention when I arrived in at the very end of July in 2015. Earlier in the year, Des Moines Water Works (DMWW), the capital’s drinking water utility, filed a lawsuit against three upstream drainage districts² for polluting the Raccoon River, requiring the utility to build and maintain expensive nitrate³ removal equipment to meet the national drinking water standard of 10 parts per

² Organizations that have some authority in controlling and protecting surrounding land and waterways from the drainage systems coming off farms (drainage ditches, etc.).

³ A water soluble form of nitrogen and a key player in this story (see Chapter 5)

million (ppm). The utility claimed the districts were responsible for the drainage tile from farmers' fields. Farm drainage tile is subterranean, privately installed, and capable of drastically altering hydrological cycles. These drainage tiles discharged into drainage ditches, creeks, and rivers, and therefore the tiles were implicated in levels of nitrates far above the drinking water standard (see Chapter 3 and Figure 3.13). On my first full day in Iowa, the 30th of July, the average level of nitrates in the North Raccoon River near Sac City was 11.1 mg/l. In the Cedar River near Palo, the average level was 6.9 mg/l. Both of these locations, as I will explain, had different political significance for the state of Iowa.

People called the drinking water utility's CEO Bill Stowe both a hero and a self-serving self-promoter. Farmers, farm groups, and even the governor cried foul, saying Stowe was picking on rural Iowa and farmers, choosing small counties without much money. They pondered his intentions. Was he angling for a position in the EPA? Was he one of those radical anti-farm activists? They described DMWW employees surreptitiously collecting water samples from tiles and testing them at the Iowa Soybean Association (ISA), a well-respected producer association in the state known for their environmental services work, without ISA's knowledge of the samples' origins. In nearly all of my conversations with farmers, they brought up the fact that DMWW dumps the wastewater from the nitrate removal facility back into the Raccoon River. Other people—environmental activists, some politicians, some natural resource professionals, and even a handful of farmers—believed that Stowe was right, that farmers were at fault and something had to be done. They discussed the ways in which agriculture had drastically altered Iowa's landscape, and drainage tile had a particularly potent role in altering the hydrology and soil of Iowa. Some people agreed with the content of the lawsuit but not

the strategy, stating it was divisive and counterproductive to conservation goals. Within this context of intense political debate, I navigated how Iowans framed environmental problems and proposed/implemented solutions, and the environmental relationships that these problems and solutions revealed.

1.2 A Brief Note on Language

Throughout this dissertation, I make several choices about language that are deliberate. In anthropology, we tend to put more value on “emic” terminology, or the language used by the cultural experts anthropologists study (with), over “etic,” or the presumably objective language of a trained outsider (i.e. a social analyst like an anthropologist). In Iowa, my research participants would reframe *water pollution caused by industrial agriculture* to *water quality issues* and *production agriculture*, or perhaps *commodity* or *row crop agriculture*, and question my use of *caused by* (see Chapter 5). I use industrial agriculture because that is what is salient for the academic world, and I address the academic world with this research more than Iowans, who know much of what I discuss here as cultural experts of their own worlds. I use water pollution because it is more specific than “water quality” to what I am discussing; water quality is too ambiguous and ambivalent. Overall, my research participants would not agree with my describing their farming as industrial agriculture because a law prohibits corporations from owning farming operations, making families the primary business owners. I learned to use culturally salient terms in the field, and use them occasionally throughout the dissertation. For example, hog confinements, hog barns, and CAFOs (Confined Animal Feeding Operations) as well as climate change, erratic weather, versus resilience refer to the same phenomenon. However, the interpretation and usage of these terms reflected the speaker and intended audience. Finally, I use conservation experts or specialists when

discussing a very diverse group of people who work on conservation issues. This is my generalization of their labors in Iowa, within their professional and personal lives. It spans their employment with state, federal, or local governmental agencies; or producer associations; or non-profits. It includes whether they are volunteers (SWCD commissioners, County Conservation Board members); activists; or professionals. Often their work focuses on particular natural resources, landscapes, or social groups. Many of these people are easily recognizable within Iowa as well, so my generalization is an effort to maintain the anonymity I promised to them during our conversations and my observations.

1.3 Dissertation and Chapter Outline

This dissertation is an anthropological exploration of a sociocultural-environmental problem: water pollution created primarily by industrial commodity agriculture. It is also a ground truthing project, in that I focus on the local and state efforts to address this pollution. This term was used in my field site, and in other disciplines, to mean drawing on direct observation rather than inference, specifically measuring how conservation practices and agriculture impact the landscape. I was interested in measuring these as well but from the perspective of sociocultural relationships. This ground truthing exploration employs ethnography, assemblage theory, and circulation studies—all described in more depth in the following chapter—because they have allowed me to address three broad themes: relationships, variation, and politics and the technologies of power.

First, I wanted to examine the (intercultural and internal) variation of actors and infrastructure within industrial agriculture, which, secondly, became clear through a relational approach to environmental interactions. Often in much scholarship and media

for the general public, industrial, capitalist agriculture is depicted as a complex but homogenous system (see Chapter 2 for scholarly review). Take the documentary, *King Corn*, or Michael Pollan's (2006) *Omnivore's Dilemma*. In *King Corn*, two college friends "borrowed" an acre from an Iowan farmer to grow their own commodity corn, after discovering from a hair analysis that they both were primarily "made of corn" (Woolf 2007). They quickly discovered they could not track their specific corn to its final form on a dinner plate due to the obscuring nature of the industrial food system. This led them to caution against the evils of corn consumption (especially high fructose corn syrup). Pollan (2006) provides a fascinating history of corn, and its rise to success, based on its own biology and entanglement in human politics, particularly federal subsidy programs, corporate interests, and research programs (university and otherwise). He follows George Naylor, a well-known Iowan corn and bean farmer who, nevertheless, is a bit odd, in Pollan's account due to his rejection of GMO seeds. Pollan's conclusion suggests that Iowan corn farmers are simply trapped into this production system. "...this is corn without qualities...Such corn is not something to feel reverent or even sentimental about, and nobody in Iowa...does" (2006: 59). His perspective reflects the typical assumption that commodity crops, its associated technologies, and industrial food infrastructure produce the same results, specifically exploitative and unsustainable ones. I was curious about how people experienced the hallmarks⁴ of industrial agriculture, such as monoculture, mechanization and technologization, and increasing but disparate scales. Specifically, I wanted to see how ecology mattered in these various capacities, materially and immaterially, in systems of knowledge and practices (Walker 2005). What I found

⁴ Input dependency has received scholarly attention (see Chapter 2). While it is very important to consider, it is not the focus of this research.

was far more interesting, insidious, and in tension with supposedly opposing forces (i.e. industrial agriculture and natural resource conservation) than a static exploitation and unsustainability of the system.

There is a serious joke in anthropology, that the answer is always, “It’s complicated.” In our horror at the degradation spinning out from profit-driven agriculture and our hopes for alternatives, it seems we do not allow this system to be complicated on the ground. We could chock up the continued pursuit of yield-profit to just ignorance, blindness, entrapment, and/or greed. Yet, during my work, exploitative and unsustainable agricultural practices were tangled up with historic nostalgia and pride; innovation and experimentation; and longing for collaboration and change. Assemblage theory is a way to conceptualize these dynamic and complicated social relationships, and ethnography gave me insight into the ways of living within this system. This does not dismiss the detrimental consequences of industrial agriculture and the essential work of scholars documenting it and envisioning change. Rather I plunged into the proverbial belly of the beast, to witness and record what life was like. As an anthropologist, I cannot ignore the ever mounting scientific evidence of ecological and social degradation throughout the industrial agrifood system (see Chapter 2), nor can I presume that there is so little variation in how to traverse a landscape utilizing GMOs (Genetically Modified Organisms), pesticides, and \$300,000 combines with GPS technology that it is unworthy of study using nuanced and messy methodologies like ethnography. Where there are humans, there is agency, potential, and change, even in the face of extremely powerful corporate, state, and political systems and entities, with profit directing desire.

Third, I wanted to consider the politics at work, at different but still co-constituting scales, and specifically the techniques used to establish power, within industrial agriculture. In Iowa, I met determined, passionate people advocating for and enacting lively and vital landscapes—trails winding past prairie, hosting monarch butterflies; waterways to boat, swim and fish in; farms connected to local food economies and rebuilding soil; and young people raising their families happily in a vibrant Iowa. Yet many of these passionate people—with resignation—cited the “status quo” impeding and slowing their work. What was the “status quo,” and how did it come to be? What made this vital landscape-work so difficult to do? Why was there resistance against the desire to conserve the natural resources providing the foundation of agricultural success or resistance against the desire to farm in ways promoting long-term sustainability for people and the landscape? Circulation studies gave me the analytic tools to consider the relationship between power and knowledge, and how this relationship affected the relative mobility or immobility of ideas and practices (Briggs 2007a and 2007b; Briggs and Mantini-Briggs 2016; Latour 1987; Lave 2011). Ethnography provided one vehicle to trace these movements, through conversations and on-the-ground observation, as well as discursive analyses of media.

Ethnography traditionally has referred to data collection generated through living with a group of people in a particular place, i.e. a community; learning their language(s); participating and observing daily lives and rituals; asking questions; and utilizing other methods that rely on the application of discomfort and strangeness. Ethnography has been stretched past the concept of the community, following such globalizing forces like commodity chains and migration (e.g. Ziegenhorn’s 2000 chapter on seed corn; De

Léon's 2015 study on U.S.-Mexico border crossing), concentrating on culture done in geographically disparate places (e.g. Helmreich's 2009 study of microbial science and Boellstorff's 2008 study of online gaming), and moving beyond humans (e.g. Haraway's 2008 broad nonhuman overview; Helmreich's 2009 study on aquatic microbiology; Kohn's 2013 study on forests; Tsing's 2015 study of mushrooms). I also stretch ethnography, to the point where I asked if I was even doing it anymore. What was ethnographic in learning about soil microbes, cover crops, or nitrate pollution in water? I wondered. I recovered from this methodological uncertainty, realizing I had learned a new language—a technical register associated with the Iowan ways of speaking about farming and conservation. I had been ritually initiated by falling into a creek while water testing, and driving a combine (with GPS steering, thankfully) and an antique tractor. Instead of asking questions, some people referred to me as having answers. I moved from cultural amateur to “honorary Iowan” status. In these moments, I realized community (of a place, of practice) was not the only meaningful unit of sociocultural experience, and that analyses of problems requiring social organization could benefit from an ethnographic lens.

The social worlds in which I operated were small, even intimate, despite the wide expanse of Iowa. I would see the same people at conferences and field days. People knew and referenced each other in predictable and unexpected ways during our interviews and conversations. Sometimes they told me to talk to specific people. Other times someone would simply come up in conversation, and I had met that person just before this interview in session. There were also fractures, showing where there were disconnects between particular social groups. They did not live in the same areas of Iowa necessarily,

nor they did do the same work, so I struggled to describe the relationships between people I worked with and these nonhuman entities. I had initially been interested in the idea of the assemblage, but after my fieldwork changed drastically and I simply immersed myself in understanding agriculture and natural resource conservation, theory felt far away. Yet in my troubled state to convey the relationships I had seen, I returned to the assemblage, and the more I went into data analysis, the more I realized this was the framework that could help me describe what I had witnessed and experienced.

Assemblage theory allowed for emotions, care, and desire to move it (Biehl and Locke 2010; Deleuze and Guattari 1987; Müller 2015; Müller and Schurr 2016). Machines and other technologies, plants, microbes, and rivers all could move in concert with humans within the assemblage. Histories, context, labor, and intrinsic natures all mattered in the arrangement of social relations. In particular, assemblage became useful for me in several ways. First, it accounted for more than human actors in contributing to meaningful interactions and changes. Second, it organized these interactions around a co-constituting desire. Finally, it used processes of claiming and losing “territories” to imagine the work done in service of the desires moving the assemblage. These facets of the assemblage allowed me to envision what I call the corn assemblage and the prairie assemblage. These assemblages are specific to my fieldwork. They became clear to me only based on the specific temporal-spatial moment of the Des Moines Water Works lawsuit coming on the heels of the Iowa’s Nutrient Reduction Strategy.

What then is the nature of these assemblages? Actors in the corn assemblage desire the continuity of the farm. Actors in the prairie assemblage desire change of the Iowan landscape. How could these two desires possibly coexist, when one seemingly

needs static consistency and the other radical shifting? How could they interact without derailing each other? Boundary objects provide explanatory power (Bowker and Star 1999; Star and Griesmeier 1989; Star 2010). In this dissertation, the boundary object that allows groups and entities to work together without consensus is conservation (Star 2010). The idea of conservation has had a long-standing history and material-ideological role in Iowa. I ground conservation in the physical landscape of Iowa as well as its ideological history, as the Natural Resource Conservation Service has been around for the last 80 years, and environmental stewardship has ideological significance within farming (Comito et al. 2013a). Actors in the prairie assemblage and actors in the corn assemblage could organize around conservation of the Iowa landscape, and they shared infrastructure that is meant to facilitate conservation (see section 2.4 for more detailed discussion of infrastructure). Yet conservation was vague and malleable enough that the assemblages could have internal definitions focusing on continuity or change, as well as assemblage actors creating strategies that attempted to bring these desires and internal definitions into productive relationship. What needs to be conserved, and why?

It is with these goals—relaying the complexity of a socio-environmental system, and how that system sustains and fails to sustain itself, through labor, ideologies, and discourse of people, and their interactions with nonhuman actors—that I bring the theoretical traditions of political ecology, Science and Technology Studies (STS), and posthumanist studies to bear on my ground truthing project. What follows is an overview of each chapter.

In Chapter 2, I discuss the interactions and relationships between science and knowledge, politics, ecologies, and other vital matter theoretically and methodologically.

I use the combined frameworks of political ecology, STS, and posthumanism, with a brief overview of each, and their productive intersections to consider the interactions between water and industrial agriculture. Political ecology can speak to power manifested through ecologies, and how those ecologies affect and contribute to power. Political ecology has been responding to the material turn recently, in order to bring back the ecology into its analysis, rather than excluding ecology to an ideology-discursive realm (Walker 2005). STS and posthumanism can speak to more than human relationships producing complex social worlds. STS brings in technology, ideas, nonhumans, and humans into the co-production of scientific knowledge. Posthumanism make these worlds lively, not necessarily alive or intentional, but capable of creating change through their intrinsic natures and relationships. Then I review social scientific research (mainly in anthropology, sociology, and geography) on industrial agriculture and Iowa agriculture, particularly at the intersection of water pollution and the environment. I build on these scholars' work in order to consider the lively and troubled interactions between natural resource conservation and industrial agriculture. I then describe how I apply three concepts from my theoretical framework within my research, giving introductions to the idea of the assemblage, boundary objects, and studies of circulation. Finally, I discuss my experiences as a researcher, considering the politics of my identity, my role as a scientist, and the affective consequences of this work.

In Chapter 3, before building the corn and prairie assemblages and the conservation boundary object, I introduce some of the actors throughout the agro-ecological landscape of Iowa. Through a discussion of scale, vital entities, and technologies, I consider the variation present in Iowa to trouble impulses to “fly over” the

state, or the assumption we can simplify a complex landscape because of factors like monoculture and industrial production. I introduce some of the actors that work as in-common infrastructure—specifically monoculture landscapes, drainage tile, and cover crops—for the assemblages and conservation boundary object. As infrastructure, these vital ecological technologies facilitate material and ideological work. Monoculture corn and soybeans are entangled in multispecies tensions, where farmers, technology, and corporate interests try to privilege these crops’ success with their physical and emotional labor. Invisible drainage tile speeds up the hydrological cycles of Iowa, laboring so well in farm fields that consequences overflow into other ecologies and spaces, like rivers and towns and cities. Conservation practices like cover crops try to fill in the gaps in the landscape created by monoculture and drainage, yet they also run into tensions within assemblage desires. These vital materials also bring up the concept of scale, and how people have labored for the well-being of farms and waterways in Iowa. Farm acreages and watersheds both represent material and scale-making spaces that have practical, moral, and political consequences. Additionally, the issue of specialization and diversification—in this chapter, niche agricultural and livestock markets and conservation grant foci—also affects material and scalar practices and knowledge within farming and conservation worlds. The interactions between various actors and infrastructures then provide the substance from which the prairie and corn assemblages emerged.

In Chapters 4, 5, and 6, I discuss practices of the assemblage (Li 2007a). Chapter 4 brings into focus discursive and ideological distinctions—made through critique, equivocation, obfuscation and silencing, and different enrollment of human and nonhuman actors—within the assemblages around the Nutrient Reduction Strategy

(NRS) and the Des Moines Water Works (DMWW) lawsuit, as well as their material consequences. Chapter 5 examines a distinction between the assemblages made through the origins of nitrates getting into waterways. Chapter 6 discusses three material and conceptual strategies—soil health; water knowledge; and technologically mediated landscape knowledge—used by the actors within the assemblages to further as well as bridge their desires. All of these chapters detail reterritorializing and deterritorializing efforts of the assemblages, as they aim to shift the infrastructure of the conservation boundary object toward fulfilling their respective desires. I use the concept of territorialization to discuss the complicated claims of actors within each assemblage to particular ideas, relationships with actors, and infrastructure to stabilize their desires for the landscape, as well as how their claims fail to secure these actors' desires.

Specifically, Chapter 4 introduces the corn and the prairie assemblages as I first conceptualized them. The assemblages flexed, flowed, broke apart, and carried on with holes and gaps in the territorializing efforts of the human and nonhuman actors, vital entities, and technologies enrolled in them. I distinguish between the assemblages by examining how various actors structured their desires around the context of the NRS/DMWW lawsuit node.

While the assemblage provided the flexibility and nuance I needed to articulate these social groupings and their interactions over other concepts, these assemblages were entangled in the other's becoming, making them dialectical/relational. Through a variety of practices, such as empathy and uncertainty/equivocation, bridging actors—humans and nonhumans—jumped horizontally between the assemblages, even maintaining proverbial feet in each assemblage, articulating a hybrid assemblage. I consider the implications for

the conservation boundary object, of each assemblage's positioning around the NRS/DMWW lawsuit node.

In Chapter 5, I discuss how narratives about environmental relationalities inform the impetus to care or not, and how underlying ideologies and material relationships affect how these narratives were received and utilized. To do this, I track two versions of a specific narrative—the natural nitrogen cycle—through secondary literature and ethnography. The idea of a natural nitrogen cycle stemmed from an Iowa State University study that both soybean and corn fields lost about the same amount of nitrate, despite corn fields receiving fertilizer (therefore having more nitrogen available for use/loss) and soybean fields rarely if ever receiving fertilizer. The study went on to say the Iowa soil has a “bank” of natural nitrogen, 10,000 pounds or so, and soil microbes convert a certain amount of nitrogen to nitrates. Then thirty pounds of nitrate was lost to the environment, regardless of corn or soybean. In a prairie, the roots of plants would take up most of this nitrate. However, in a corn and bean system, the crops are either not there or not at a point of nutrient uptake in their life cycle. The issue then was bare ground, and the absence of a key player: plant roots. However, one version that circulated was that Mother Nature did this to herself, and how could a farmer be expected to address Her excesses? This particular version baffled me because it was so common, and so disconnected from what I thought the study was originally conveying. I utilized both ethnographic data and analysis of secondary resources to examine how these different narrative versions circulated, specifically the presentation of the information, the authority of the speakers, the audience, the genre, as well as political and ideological

dimensions. These narratives demonstrate the work that discourse did to solidify and trouble assemblage desires and the conservation boundary object.

In Chapter 6, I review three strategies within and between the assemblages to bring about desires for change and continuity: the concept of soil health; the creation of water knowledge; and technologically mediated landscape knowledge. There were numeric goals for both the soil and water—no more than five tons lost from a field annually, a reduction in nitrates and phosphorous by 45%—yet no officially sanctioned monitoring or compliance existed, which left gaps for several kinds of strategies, specifically bridging/merging, filling gaps, and expansion.

To bridge assemblage desires, soil health emphasized the biological abilities of the soil to increase soil fertility and tilth when soil ecosystems are supported through particular conservation practices, specifically no tillage and cover crops. It drew on emotions like wonder; biological science rather than chemistry and physics; and emphasized the economic and environmental benefits for farmers and soil. Soil health had become a concept different actors of the assemblage hoped could mobilize social change, improving farms and landscapes. It was this principle that groups like the NRCS, the Iowa CGA, and others utilized to encourage conservation practices.

To fill in the gaps left by entities like the NRS, individuals and groups tried to produce water knowledge through strategies such as waterway monitoring. Different stakeholders—producer associations, NRCS, the DNR, and a hydrological science program at University of Iowa—created programs to test water. Water monitoring programs had several variations; they could be anonymous services for individual farmers to find out the content of their tile line water; an assessment tool for watershed

projects to measure water quality throughout the season; or citizen science projects to engage the public in testing (knowing) water at the sites of collection.

Finally, several groups designed programs using technology to provide farmers with information about the relationships between their land and profit. Several farmers told me about programs that integrated crop yield, soil maps, and input history. They described being able to put more nuanced amounts of fertilizer on crops with this kind of information, decreasing nutrient loss, although the narrative of natural nitrogen was in tension with this. One of the most popular technological programs at the time of my fieldwork was AgSolver, a program designed to show areas of unproductive land, which had both farmers and conservation experts excited. However, despite the fascination and excitement over technology, other participants pointed out the dark side of this technology to me, that rather than pulling acres out of production, drainage tile could go in instead, to attempt to make that land productive. I also discuss how continued reliance on technology made some farmers nervous rather than excited, because they lost control over their direct participation in farm labor, which many connected to farm continuity. Soil health, water quality, and technology were often at odds, and actors in both assemblages chose different strategies to achieve their desires for the Iowa landscape. I discuss the limitations to these various strategies, as they operate on the premise that knowledge is empowering. My research found that knowledge was seen as almost overabundant and that the methods of knowledge circulation were reaching a limited audience.

To conclude, I explore the emotional context of Iowans considering their

landscape. I connect multiple trajectories of loss: loss of topsoil, of prairie, of nutrients/pollutants, of (safe) water, of meandering rivers, of wildlife, of neighborliness and community, of family farms. I identify the root of all this loss in one multiplicity: corn. Corn has received immense labor to have the powerful impact it maintains on the landscape, and its position of power has been naturalized, which I work to demystify throughout this dissertation. I share what Iowans as well as I saw for the future, what we imagined—with a hopeful as well as detached perspectives—would happen to farming and the landscape. What could fill in the gaps and empty space created by loss rooted in corn? Some hoped for conservation, local food, and young farmers. Some saw self-driving tractors and drones, both with the increasing absence of people in Iowa and an increasingly technologized agriculture. Some saw the triumph of the current corn and soybean system, and others predicted its inevitable failure. By tracing these emotional and fantastical speculations, these different visions revealed the tangibility of human agency and the mobility of that agency through existing infrastructure. I end by discussing why I chose to discuss Iowa in the ways that I have—specifically relational and complex—and why this is important.

CHAPTER 2

THEORY AND METHODS

The god of dirt
came up to me many times and said
so many wise and delectable things, I lay
on the grass listening

to his dog voice,
crow voice,
frog voice; now,
he said, and now,
and never once mentioned forever
- excerpt from Mary Oliver's "One or Two Things"

Against the backdrop of expansive corn and soybean fields, rivers and creeks, pockets of prairie and pasture, I navigated productive, troubled relationships between science, politics, and emotion across the Iowa landscape. I was a fledging anthropologist, putting into practice my largest scientific endeavor and negotiating my researcher role both among research participants and for myself. Within my fieldsite, I witnessed the valorization of science as the most legitimate epistemology, or way of knowing, as well as the dismissal of politics and emotion as valid resources for knowledge. Fieldwork, however, demonstrated the interplay between all of these ways of knowing, regardless of their broader cultural salience.

In this chapter, I introduce my overarching theoretical framework using political ecology, Science and Technology Studies (STS), and posthumanist studies for approaching the socio-ecological problem of agriculturally derived water pollution in

Iowa. After my theoretical discussion, I provide a brief overview of the important social scientific research done on industrial agriculture and its environmental consequences, specifically regarding water and soil degradation. Then, to bring together my framework and previous research, I discuss the contributions of the main theoretical concepts and domains used throughout my data analysis: the assemblage, boundary objects, and studies of circulation. Finally, I describe my methodology, which demonstrates the entanglement of politics, science, and sociality of data collection and my data itself.

2.1 Politics, Science, and More than Human Worlds

Recently, political ecologists and Science and Technology Studies (STS) scholars have brought their frameworks into conversation in order to examine the production, circulation, and application of systems of scientific environmental knowledge (Goldman, Turner, and Nadasdy 2011). Political ecology arose through the combination of political economy and cultural ecology, enabling analysis of markets and labor; natural resources and conservation; biophysical and human interfaces; and local, national, and global governance (Goldman and Turner 2011). In particular, political ecologists have examined the discursive, ideological, and political realms of environmental management, specifically how discourse and ideology impact environmental outcomes (i.e. politics of representation). Political ecology has been critiqued for missing the ecology (Walker 2005), a tendency due in part to well-founded fears of reproducing harmful theoretical perspectives like environmental determinism. However, as political ecologists have recognized the need to understand the origin and dissemination of these ideas and their material manifestations, they have turned to STS and posthumanist studies, which emphasize the interactions between materiality and knowledge.

STS scholars have studied the cultural production and circulation of scientific knowledge, a gap in traditional political ecological analyses (Goldman and Turn 2011). This field has emerged from sociology, philosophy, history of science, and feminist science studies. STS considers science to be a dynamic process and system produced by and producing social worlds through historical, political, and sociocultural processes (Law 2004). Historical analyses demonstrate the effects of imperialism, racism, sexism, and other cultural hierarchies on scientific knowledge, and ethnographic work demonstrates the daily cultural practices in the lab that make scientific “fact” (Goldman and Turner 2011).

Vital materialism (Bennett 2010; Richardson and Weszkalnys 2014) and posthumanist theory (Kirksey and Helmreich 2010) combined with STS brings into the interaction between human, technological, material, and living nonhuman worlds. In particular, I build on anthropological and archaeological contributions to materiality studies (Appadurai 2013; Beaudry et al. 1991; Gosden and Marshall 1999; Hoskins 1998; Hoskins 2006; Kopytoff 2013; Meskell 2004; Miller 2005 and 2010). Much of this work examines the sociality and relationality of people and “things,” i.e. commodities and objects of exchange value and biographical value. Indeed, taking a relational approach allows for insights such as that from Thomas (2002), where he examines how Neolithic human remains may have still played social roles in the daily lives of living people. In addition to materiality, immateriality also plays a critical role in social relationships, both in terms of non-material entities, invisible and obscured materialities, and absent materialities (Miller 2005 and 2010, Wylie 2009). I deal primarily with the latter two, specifically in the circulation of knowledge or the lack thereof as well as the absence and

purposeful obscuring of particular ecologies and their ecological significance (mainly discussed in Chapter 5). I contribute to materiality studies through my focus on ecologies rather than commodities and objects while still attending to the work on materiality studies.

In addition to work on commodities, things, and objects, attending to liveliness and materiality has been very apparent in research on water. In contrast to much of the agricultural literature, water has inspired scholars to, simultaneously, examine infrastructure (Anand 2011 and 2017; Bijker 2007; Carse 2014; Lansing 1991), global and daily politics in producing water (Alatout 2008 and 2009; Barnes 2014), sociocultural imaginaries and realities (Alley 2002; Geertz 1972; Hughes 2006), and the entangled materialities of water (Bakker 2012; Scaramelli 2013). These studies push beyond politics of representation and consider the interactions of multiple forces creating water. For example, Barnes (2014) questions the naturalization of water, demonstrating how different actors and groups use and interpret water in divergent ways in Egypt. Through her work, she examines the everyday politics and materialities that co-produce water, as a biophysical and sociocultural entity. Water flows and crosses boundaries, touching many places and other beings; it is perhaps this quality that makes water traceable. These studies—holding in tension politics, history, social and cultural life, technology, materiality, and ecology—inform my work as a method to allow materiality to inform politics of representation, discursive and ideological approaches to conservation and agricultural practices.

What does this look like—politics, science, and lively and vital materialities—in my work as a cultural and environmental anthropologist? Political ecologists and social

theorists have provided nuances to Foucault's governmentality (1991), in which politics is defined the processes of the state to subtly control its citizens through techniques of self-discipline. Ferguson (1994) describes the anti-politics machine, where the state makes its politics appear technical, scientific and therefore political through bureaucratization techniques. Similarly, Scott (1998) describes the simplification techniques of scientific forestry and high-modernist industrial agriculture. Li (2007b), building from Scott and Foucault, differentiates governmentality as the practice of government and the practice of politics. Practice of government represents the processes of the state to make and solve complex socio-ecological problems with technical solutions. Practice of politics represents the on-the-ground attempts to apply these technical solutions and the resistance against them, and all the tensions and gaps resulting from the relationship between the two. As the state bureaucratizes politics, compromise, ignorance, and other kinds of gaps leave room for destructive and productive new relationships and political alliances (Li 1999; Mathews 2005, 2008; Tsing 2008). Politics in my fieldwork is both the practice of the state to operationalize science and bureaucracy as well as the negotiations present in grounded and daily living and experience, practices that happen at multiple scales and from multiple actors.

Science is one significant domain for state and corporate control, as it is one of the primary tools of de-politicization and legitimization for profit generation. Yet in applications such as conservation practices, science's abstraction, generality, and manufactured disconnection from social life can be used discursively and practically for not trying these science-based practices *because* they are abstract and therefore not attuned to local and grounded environmental, sociocultural, and economic conditions

(Scott 1998). Local knowledge then can disrupt science's symbolic authority (Li 2005). For example, "...farmers can simultaneously claim ignorance about how specific farming practices might be harming the very land they profess to know so well" when they question the evidence connecting poor water quality and agriculture (Comito et al. 2011:28). Similarly, when corporations claim that particular technologies are both scientific and efficient, they can dominate the landscape with these technologies. Increasingly, agriculture has become an information-based practice, where farmers attend conferences and workshops, read articles, and talk to industry experts rather than work in the fields.

Through posthumanist and materiality studies, ecology provides the majority of the materialities and entities for my theorization about gaps, tensions, and collaborations in politics. Ecology is the context for the places my research participants would describe as natural, such as prairie and wetlands, and those that would waver between natural and social places, such as agricultural fields and pasture. Rivers flood; rain comes down hard and long. Wetlands are drained and restored. Combines rumble across fields for several months and lay hibernating in sheds. Soil yearns for plant roots. The prairie blooms along the edges of fields, and slowly, in the middle of them. Iowa's soil is almost too good; there is too much water. There is not enough slowness or liveliness in either. Technology creates productive and destructive gaps, and bridges between the landscape and humans. These were the relationships that made a difference in industrial agriculture in Iowa versus industrial agriculture in other places.

In summary, political ecology is the backdrop to all that I study, due to the interactions between politics, ecology and the knowledge systems attending to ecology.

Through the analytic frameworks and tools of STS, I traverse these political, ecological, and social landscapes, specifically through a subset of circulation studies and the boundary object, which recent scholarship has infused with power as well. Posthumanist studies, specifically the assemblage, provide the method for accounting for lively, complex, living and nonliving actors and their emerging and co-constituting relationships.

2.2 Agriculture and Water in the Literature

Agriculture has captured ethnographic attention throughout anthropology's history. When scholars discuss industrial agriculture in the United States,⁵ there have been two main trajectories: the development of and socio-ecological ills arising from industrial agriculture (Buttel et al. 1990; Guthman 2014; Goldschmidt 1978; Madgoff et al. 2000; Netting 1993; Thu and Durrenberger 1998), and the lives of the farmers growing the commodities for these systems (Barlett 1993; Bell 2004; Chibnik 1987; Dudley 1994; Ramirez-Ferrero 2005; Salamon 1992). Both of these trajectories have strong traditions of historic and political economic analyses. For the first trajectory, scholars have discussed the relationships between industrial agriculture and state power (Durrenberger and Thu 1997; Pritchard et al. 2016; Scott 1998; Thu 2001); industrial agriculture and corporate power (Baines 2015; Friedmann and McMichael 1989; Gillon 2010; Grey 2000a; Kinchy 2012; Kloppenburg 2005; McMichael 2009; Weis 2007 and 2010); and the co-constituting relationship between the two. These works highlight the

⁵ In this literature review, I focus on domestic studies of industrial agriculture rather than the consequences documented abroad as industrial agriculture is forcibly and voluntarily adopted cross-culturally. Much of this work also documents corporate power in the global agrifood system (for some examples of this work, see Borras and Franco 2011; Holt-Giménez and Patel 2009; Patel 2007; Pretty 2003; Shiva 2000 and 2016b; Stone 2002).

role of powerful institutions in determining the structure and trajectory of the agri-food system at multiple scales. I return to the second trajectory later in this section.

A political ecology perspective on industrial agriculture in the United States can contribute several theoretical insights into this rich work on the national, global, and local consequences of industrial agriculture (Galt 2013). Much of the research on industrial agriculture in political ecology currently considers the consequences of its application outside of the U.S. As Swanson (2017) encouraged anthropologists, we must consider the sites that originate these socio-ecological ills, like Iowa, rather than mainly working in the places dealing with the consequences. Scholars have considered the agricultural and rural landscape of Iowa in a variety of contexts, including sustainability initiatives (Bell 2004; Janssen 2017); the struggles over hog confinements (Durrenberger and Thu 1996; Grey 2000b; Thu and Durrenberger 1998); changes in the rural landscape, especially with rural industrial production (Fink 1986, 1987, and 1998); ethanol and the rise of biofuels (Gillon 2010); and water pollution and conservation, which I discuss later in this section. The ecology is lost in most academic considerations of industrial agriculture as well, due in part to the system resulting in environmental degradation rather than environmental renewal, as well as the tendency to treat the agricultural landscape as an inert entity (for exception, see Li 2014).

The importance of ecology is evident in recent ethnographic work on American agriculture, such as the lively considerations of cheese and cheese-making (Paxson 2013) and of pastured pork (Weiss 2011 and 2016). The sensory experiences of raising, making, and eating these artisanal products demonstrate how ecological relationships inspire affective responses, invigorating economic livelihoods. However, in their work, industrial

agriculture is a black box, discussed for juxtaposition rather than interrogated as an object of study. Here I build on the strength within the second trajectory in industrial agriculture research that I cited, the ethnographic work with farming families and communities participating in commodity agriculture (Barlett 1993; Bell 2004; Benson 2011; Chibnik 1987; Dudley 1994; Kingsolver 2011; Ramirez-Ferrero 2005; Salamon 1992). Much of this work emerged in the wake of the 1980s farming crisis, and due to the polarization between family farms versus profit-driven operations (Barlett 1993; Chibnik 1987; Salamon 1992). As Comito et al. (2012) point out, in Iowa, today these tensions also exist within the same farmer and farming operation, rather than between various farmers and their operations. My research explores what life was like within industrial agriculture—large-scale, mechanized and technologized, profit driven, cash crop monoculture. Similar to Blanchette’s (2013) consideration of how pigs challenge industrial processing with their liveliness, my work asks questions about these lively ecological relationships but within an industrial agricultural context. Rather than focusing on a commodity like corn, I focus on the landscape of Iowa as a whole, a multiplicity.

I attend to the liveliness of the Iowa landscape at the intersections of natural resource conservation and industrial agriculture. Social scientific scholarship examining agriculture’s negative environmental impacts, specifically on water, shows a range of theoretical approaches and are foundational to the work presented here. In particular, work by geographer Rebecca Roberts and the collaboration arising from *Water Quality Matters to Us All* (Comito et al. 2011)—much of their work based in Iowa—have provided me with essential baseline information for my methodological and theoretical approaches. When considering pollution and conservation within industrial agricultural

systems, scholars generally analyze pollution and conservation within industrial agricultural systems from cognitive and discursive perspectives (Comito et al. 2011, 2012, and 2013a; Emery 2010; Paolisso and Maloney 2000; Paolisso et al. 2013), historic analyses (Moore et al 2008; Shoreman and Haenn 2009; Shoreman-Ouimet 2010), or analyses of political power (Comito et al 2013b; Jackson 2008; Lighthall and Roberts 1995; Roberts and Lighthall 1991; Thu 2001). The first two categories generally focus on individual-level decisions and experiences, while the last category considers state-level structures. However, connections are made between the two (e.g. Comito et al. 2013b; Durrenberger and Thu 1996; Lighthall and Roberts 1995; Roberts and Emel 1992; Thu and Durrenberger 1998).

This work has contributed important insights in general and to my research specifically, such as the following. First, anti-government sentiment has led to environmental conservation compliance in some contexts, although not Iowa (Moore et al 2008; Shoreman and Haenn 2009; Shoreman-Ouimet 2010). Second, the state and corporation wield (political and cultural) power to structure agriculture in ways favoring capitalist productions rather than social and ecological benefits (Durrenberger and Thu 1997; Jackson 2008; Thu 2001). For example, Jackson (2008) identifies federal farm policy like the Farm Bill and agribusiness as the primary “designers of the landscape” rather than farmers. Finally, this work has detailed the discourse used to claim but not necessarily enact environmental stewardship and agriculture (Comito et al. 2012 and 2013a).

Drawing on the data from *Water Quality Matters to Us All* (Comito et al. 2011), Comito et al. (2012, 2013a, 2013b) describe the multiple ways in which status quo

agricultural practices contributed to an “anti-conservation machine” in Iowa, similar to Ferguson’s “anti-politics machine” (2013b). Comito et al. (2012, 2013a) explore the contradictions within farmers naturalizing their positions as good stewards of the land. Farmers claimed ignorance of the connection between poor water quality and conservation practices, as well as the necessity of being savvy businessmen who could feed the world by increasing their yields and their profits (Comito et al. 2013a). Farmers also claimed conservation practices like “minimum till” or “no till” through an “art of farming” framework, or the local and experiential knowledge of farming in a particular place, as put forth by Paolisso and Maloney (2006) (Comito et al. 2012). Yet Comito et al. (2012, 2013a) found denial of knowledge, claims of farming arts, and position as hero all in fact impeded positive changes to practices, like adopting no till.

Rebecca Roberts and her collaborators discuss the interplay between capitalism—specifically in the context of agriculture, water use, and water pollution—and ecology through political ecological and economic lenses. Their analyses illuminate how state structures—often state-sanctioned research programs like land grant universities and extension—impeded the progress and adoption of low-input technologies (Lighthall and Roberts 1995; Roberts and Lighthall 1991). They also discussed the need to expand the economic value of restored wetlands to include intrinsic values (Lant and Roberts 1990). Finally, in the context of the Ogwalla aquifer, they discuss the importance of considering “uneven development”—which uses a perspective that capitalist competition creates a landscape of change, growth, and decline that social actors must navigate—rather than the tragedy of the commons model, which focuses on property rights (Roberts and Emel 1992, see also Gray and Gibson 2013).

What was striking to me about these research collaborations on water pollution and industrial agriculture is that many of my findings echoed their work. Some participants told me they were frustrated that nothing substantial had changed since the inception of NRCS (formerly the Soil Conservation Service) in the 1930s. Others said they worried that current watershed projects were the same iterations of failed and failing infrastructure with new names. As Chapter 4 discusses, neither regulatory nor voluntary approaches for conservation inspired much confidence, particularly for those involved in natural resource conservation (Comito et al. 2012; Roberts and Lighthall 1991). Comito et al. (2012) articulated the need for changes in consciousness. Roberts and Lighthall (1991) discussed levying a tax that could fund research outside of the state-sanctioned programs to explore the full range of innovative potential, without pandering to capitalist markets. Thus, scholars tried to imagine ways to conservation adoption outside of the current failures of bureaucracy and neoliberalism.

What can a political ecology, STS, and posthumanist framework add to this rich conversation about the environmental consequences of industrial agriculture, and the politics and culture embedded therein? In turn, what can the relationship between industrial agriculture and natural resource conservation do for a framework drawing on the cultural practice of science, lively more-than-human worlds, and the politics within and between these materialities and systems of knowledge? In general, scholars call for more connections between structural analyses and ethnographic insight (Buttel et al. 1990; Thu 2001). To do this, I consider both agriculture and natural resource conservation's roles in constructing the Iowa landscape materially and ideologically, positioning them not as equals in terms of power but equally important within my

analysis (e.g. Gray and Gibson 2013). Much of this research tends to focus on the agriculture as the site to consider in terms of change and power. This focus has meant a lack of attention to how conservation as practice and discourse interact with and co-construct the agriculture. Additionally, nonhuman actors enrich understandings of both agriculture and natural resource conservation with their vital materialities, showing the limitations, gaps, and surpluses that create much of the politics in ways that a politics of representation approach undertheorizes (Blanchette 2013; Gray and Gibson 2013). Therefore, this dissertation provides insights into how power as well as cultural change and stasis operate in these social worlds. Additionally, this research responds to several calls coming from political ecology and agricultural anthropology.

Although Blaikie and Brookfield's foundational political ecology work focused on soil degradation and conservation in the context of agriculture, Galt (2013:639) noted an otherwise curious "lack of engagement" with agriculture, as well as conservation, in "first world political ecology" (for an exception, see Lighthall and Roberts 1995). Specifically, "sustainability...is not just a technical problem with technical solutions but also (1) a problem of social organization, because the main problem is production pressure on resources, created through pressures for accumulation and social mechanisms of surplus extraction, that is, the quest to maximize short-term capital accumulation at the farm level and beyond (Blaikie and Brookfield 1987)" (Galt 2013:649). Therefore, I consider two versions of sustainability, one based on the social unit of the farm and the other on the revitalization of the Iowan landscape, through my discussion of the corn and the prairie assemblage, respectively. Additionally, I respond to the call from Thu (2001) to examine the relationship between local knowledge and state power, as well as to both

Barlett (1989) and Crane (2014) to critically examine agricultural science.⁶ In particular, I take inspiration from Lyons (2014) and Puig de la Bellacasa (2015) and their work on soil science and perceptions of the soil. They discuss human-soil relations as entangled and interdependent, a tension I both examine and describe in my own work. By incorporating farmers' local knowledge into agricultural and environmental science, scholars have found potential for change (Kloppenburg 1991; Maloney and Paolisso 2006), as well as the potential for stagnation (Comito et al. 2012). There has been some interdisciplinary work considering the interplay between STS and agricultural social science (Crane 2014; Gray and Gibson 2013), and my work builds on this recent and growing trend. Agricultural scientific knowledge, local knowledge, and state and corporate power are all interrelated and will be addressed in this dissertation.

Combining STS and political ecology has allowed scholars to consider the production, circulation, and application of knowledge and materialities, to which I add posthumanist insights concerning more than human worlds. Industrial agriculture and all its technologies, scientific knowledge and research, and consequences provide a perfect topic for these theoretical perspectives' merged strengths. In the next section, I discuss three analytical tools and areas to address my questions about variation, relationships, and the labor and mechanics of power. Assemblage has become a popular analytic coming from Deleuze and Guattari (1987), whose work has greatly influenced scholarship using posthumanist frameworks. Boundary objects come from STS as a way that groups work together without consensus on a particular issue (Star and Griesemer 1989; Star 2010).

⁶ Scholars have explored biotechnology's role in the development of GMO plant varieties and seed (Kinchy 2012; Kloppenburg 2005; Shiva 2016b; Stone 2010; Ziegenhorn 2000); however, I am interested in science concerning conservation and environmental applications, rather than agronomic scientific developments.

Circulation studies have traditionally been conducted within STS (Latour 1986, 1987), but recently considerations of power/knowledge and the role ideologies underpinning systems of communication managing the production and circulation of information have become more prevalent (Briggs 2007b; Briggs and Mantini-Briggs 2016). Combining these theoretical concepts provides nuanced ways to conceptualize social organization and action, political contexts and consequences, and more than human social worlds.

2.3 Assemblage

When trying to conceptualize how to convey the social organizing I anticipated and witnessed in Iowa, I kept returning to the idea of the assemblage (Deleuze and Guattari 1987) and assemblage theory (Collier and Ong 2005; DeLanda 2006; Escobar 2010; Jensen and Rødje 2010; Marcus and Saka 2006). While assemblage does not belong to any one discipline or topic (see Acuto and Curtis 2014; Jensen and Rødje 2010; Müller 2015; Müller and Schurr 2016 for disciplinary overlaps and histories of using assemblage), I have found posthumanist and ecological considerations the most helpful (Li 2007a; Sundberg 2011). The assemblage is always political, motivated by desire and territorializing efforts, and while it has been contrasted with Actor Network Theory, some scholars (e.g. Müller 2015; Müller and Schurr 2016) have demonstrated the synergy between the two. Building on previous works and collaborations with Félix Guattari, Gilles Deleuze described the assemblage as

It is a multiplicity which is made up of many heterogeneous terms and which establishes liaisons, relations between them across ages, sexes and reigns – different natures. Thus, the assemblage's only unity is that of co-functioning: it is a symbiosis, a 'sympathy'. It is never filiations which are important but alliances, alloys; these are not successions, lines of descent, but contagions, epidemics, the wind (Deleuze and Parnet 1987:69).

The assemblage is relational; productive; heterogeneous; caught in a dynamic of deterritorialization and reterritorialization; and desiring/wishing (Müller 2015:28-29;

Müller and Schurr 2016). In other words, this definition of assemblage means that various entities (a multiplicity) enter/are entered into/break relationships through which they exert (and fail to) efforts (territorializing) to achieve a desire/wish. The English translation of *agencement* to *assemblage* has deemphasized the fact that the assemblage is made and does work, and the dynamism between these entities coming together in it. What drives the assemblage to form is desiring/wishing, and in fact, Deleuze and Guattari called it “the desiring machine” before *agencement/assemblage* (Buchanan 2015; Müller 2015). Buchanan (2015) suggests “arrangement,” along the lines of musical arrangement to emphasize the process, work, and connection between an abstract like music and the concrete performance of music. He connects *agencement* to Deleuze and Guattari’s translation of the German *Komplex*, as in Freud’s Oedipal complex, an oft-ignored relationship.

Critiques of popular uses of the assemblage (Biehl and Locke 2010; Buchanan 2011, 2015; Bueger 2014; Müller 2015; Müller and Schurr 2016) tend to focus on these issues: desire moves and motivates the assemblage; and it is both concrete and abstract, tangible and intangible, real and virtual. They lament the assemblage being used as little more than a metaphor (Buchanan 2015; Bueger 2014) or efforts for overarching theorizing (Bueger 2014, critiquing DeLanda and others). Along with Bueger (2014), I am interested in the assemblage as an empirical concept and project.

In considering some of Deleuze and Guattari’s interests (e.g. madness, the state), and their engagements with Freud and Foucault, their discussion of assemblage became clearer to me. Their interests are anchored in two independent but interrelating planes of action (the mind and the body) and the emergent relationships, from multiple causes and

events, coalescing for particular purposes (i.e. desires). If a person's life could be considered an assemblage, their desire being to live, the multiple events leading them to a moment cannot be separated out; it is all immanent and present in that person.

The assemblage is contingent on the emergence of exterior social relationships—alliances—between multiple heterogeneous entities: humans, nonhumans (living and nonliving), technologies, and ideas (Müller 2015; Müller and Schurr 2016). These entities are always only partially enrolled into their assemblage, ever retaining the capacity for slippage, escape, lost potency, and claims by other assemblages. These alliances may be strong, weak, shifting, and gaping in order to propel the assemblage toward and away from its desire as the assemblage recognizes potential and actual power. These alliances may also be intentional and unintentional, by which I mean that desires of different actors and entities may work together purposely or simply in tandem. These movements of the assemblage encompass efforts of reterritorialization and deterritorialization.

“According to Deleuze, desire—via the inventions, escapes, and sublimations it motivates—is constantly undoing, or at least opening up, forms of subjectivity and territorializations of power... Thus, an assemblage, they [Deleuze and Guattari] wrote, is ‘a concretization of power, of desire, of territoriality or reterritorialization... But we must declare as well that an assemblage has points of deterritorialization; or that it always has a line of escape by which it[...] makes the segments melt and[. . .] liberates desire from all its concretization...’ (Deleuze and Guattari 1986:86)” (Biehl and Locke 2010: 323).

Reterritorialization indicates the stabilization of the assemblage and concretization of desire, power, and relationships achieving this while deterritorialization represents the dissolution and weakening of the assemblage in reaching its desires (Biehl and Locke 2010; Deleuze and Guattari 1987; Müller 2015). As Müller (2015) points out, both de/reterritorialization are processes of power, claiming and losing to claim to particular practices, ideas, and entities for achieving desire. Although anthropologists have used the

assemblage to discuss relationships across scales and entities in the past (Ong and Collier 2005), they focused on global power structures and the abilities of assemblages to standardize and enroll rather than the messy potentials of social organization. In addition to considering the assemblage's attempts to smooth and homogenize, I attend to its failures and losses that happen across scales (Biehl and Locke 2010).

Assemblage allows nonhuman entities to matter—a benefit over social network analysis and other human centric frameworks (Müller 2015; Müller and Schurr 2016; Roffe and Stark 2015). Throughout this dissertation, I discuss various plants, nonhuman animals, technologies, landscapes, and ideas that make a difference in creating Iowa as it was during my fieldwork. Assemblage also allows both intrinsic and contextual aspects of different entities to matter as well as the organizing power of human bodily agency, a weakness of Actor Network Theory. These various actors all have histories and internal qualities about them, which must be considered when they are interacting with other actors and entities. The relationships emerging from these interactions are not created simply in that moment. Finally, assemblage organizes around the idea of desire, which lends to identifying motivations and directions (Biehl and Locke 2010). Recent anthropological and social scientific research has used the assemblage to explore agricultural and environmental intersections (Forney et al. 2018).

Desire and agency in the assemblage and more broadly posthumanist studies are embroiled in contentious debate. Who and what has agency in contributing to events and desires? Scholars generally take two approaches to this question in their interpretation of Deleuze and Guattari—that they deny humans agency altogether or that they grant humans agency, particularly in terms of the “affective assemblage” (Bowden 2015).

“...for Deleuze, a human being is essentially embodied, embedded, and affectively open to its world, and that the mostly non-conscious settling-into-patterns of complex feedback loops between brain, body, and environment explains the human being’s real-time direction of its action in the world” (2015: 78). I place my work within this second approach. I recognize that human intention and action becomes entangled and co-productive with other species, entities, and matter, so much so that human influence and activity cannot be solely ascribed to our species. We enlist, intentionally and unintentionally, the help of too many others in our projects of survival, thriving, and being.

How then to talk about the various species, things, and forces in a way that shows relationships but also attend to hierarchy and power? I do not subscribe to the aspects of STS, posthumanism, or vital materialism that all things in relationship are the same in their ability to act, be affected/affect, and co-produce. So, I use Actor Network Theory’s “actor” for living beings that have their intentions, but not necessarily ones I am privy to as a researcher (human⁷ or otherwise), as well as beings and entities that through their intrinsic natures and work have affects/effects if not discernible consciousness or intention we attribute to some life. Living beings have a primary goal to survive and live well, so in this sense, their actions and affectability are somewhat equal and may or may not align with other beings living well. But not all living-well projects have equal access to the necessary resources, being obstructed in some fashion by powerful and mundane sources, a critique from feminist and postcolonial studies of posthumanism’s and STS’s

⁷ Note that I only ask questions of human actors, while I imagine what the role of various nonhuman actors could be (their “answers” derived from observational analysis rather than interviewing).

tendency to flatten out power distribution. Water is of secondary important to agricultural commodity crops and soil. Non-farmers have less power than farmers in Iowa. These distinctions must be addressed, and when using the flattening “actor,” I try to keep in view the power differentials at play.

Technologies and vital matter (Bennett 2010) also play important roles in my work, as well as species so tightly bound together they cannot be considered without each other. Water, specifically flowing water like rivers, and soil are composite entities of organic and inorganic matter, life and non-life. Technologies like drainage tile, combines and tractors, computerized landscape models and maps, and rain simulators and water sensors join and affect the assemblages’ trajectories and desires. I would also call hybrid corn seeds and cover crops technologies, although they live as well. To navigate these complex entities, I draw on Bennett (2010) and Haraway (2008). From Bennett, I take her vibrant matter and vital materials to highlight the vibrancy of non-life—the mineral glitter of soil, the roar of hydrogen and oxygen bonded together—making water—and racing through the crevices of earth, the marriage of metal and oil in farm equipment—even as it is caught up in life and living, politics and power. I use “vital/vibrant entities” to indicate rivers, soil, and prairie—assemblages in and of themselves driven by nonhuman “desires” and ways of being, and implicated in human desires. The phrase “vital/vibrant technologies” emphasizes the human interface with mechanical and information-based technical assemblages, but nevertheless exceeding and underwhelming human desires, granting these technologies an unsettling affectability.

In addition to vitality and vibrancy, I also draw on Haraway’s “companion species,” although she is passionately critical of Deleuze and Guattari, who she sees as

dismissing the world of the mundane and the domesticated dog, her most recent relationship of interest (Bogue 2015; Haraway 2008). Bogue (2015) suggests keeping the distinction between Haraway's cyborg (e.g. Haraway's father using a wheelchair and crutches) and companion species (e.g. her agility sport dog), as he sees value in the productive tension between becoming-machine and becoming-animal. However, I draw on companion species/technologies to describe the interdependence between people and nonhuman species (e.g. corn) as well as people and machines (e.g. combines). This is in part to show that companion relationships do not only encourage care and responsibility, but that sometimes humans ally ourselves in troubling, problematic ways.⁸ I introduce these other categories of vital and companion, not to judge what the internal attributes of a species, thing, or entity consists of but rather their contributions to relationships and events. I will not go so far as to consider blaming microbes or technology for civilization collapse or catastrophe, as the extremes of posthumanism could. I will hold space for more than human activity contributing to the state of our world as we know it, which these distinctions attempt to do. Most of the time I will name whoever or whatever I am discussing—corn, farmer, combine, conservation expert, river, tile—but I do preface some of these discussing with more analytic specificity to show how I see these different actors and entities working at particular moments.

One of the most useful case studies exploring the idea of assemblage is Li's (2007a) discussion of community forest management in Indonesia. She describes the diverging groups interested in the forest, mainly villagers and forestry bureaucrats, with

⁸ Haraway (2008) does consider problematic alliances, where humans have made nonhuman animals "killable" such as animals used in experimental laboratory science and consumption. I extend these considerations to non-animal alliances as well and beyond attempts to make these relationships ethical.

many other interested groups, and the six different practices of the assemblage that can hold it together as well as fracture it. However, it was unclear to me what the desire of the assemblage was in the context of community forestry, which is the co-constituting and imperfect force driving the assemblage. In another example where nonhumans play vital parts in an assemblage, Sundberg (2011) discusses how natural resource conservation desires and immigrant rights groups' desires align in the context of border patrol. For the preservation of charismatic species like ocelots and vastly reduced Tamaulipan Thornscrub ecologies, both groups are able to argue against clear cutting and spotlights (which disrupt the cats' breeding cycles), protecting human and nonhuman inhabitants of the area. It was Sundberg's account that inspired my consideration of the assemblage.

When I came to Iowa, I expected to study the hypoxia assemblage, or the groups and entities organizing to reduce the dead zone in the Gulf of Mexico. Instead, I found the prairie assemblage and the corn assemblage. It is easiest to describe the desires motivating the actors within each assemblage, as well as common areas of reterritorialization/deterritorialization. Their relational, heterogeneous, and co-productive natures will become clarified in subsequent chapters since I found it was not helpful to describe who or what might be enrolled conceptually into these assemblages. Actors in both of these assemblages desire conservation. Actors in the prairie assemblage desire an ecologically restorative conservation, a re-incorporation of the lively landscapes before colonial settlement of the prairie into Iowa today. Actors in the corn assemblage desire the continuation of the (family) farm, under threat not only from ecological degradation but low prices, debt, fluctuating land and rent prices, agribusiness and operational consolidation, and other capitalist market forces. It is especially important to note that

actors and entities were often part of and participating in both assemblages (as infrastructure, collaborators, resistance, etc.). They had different meanings and/or roles depending on the assemblage, but many people I spoke to expressed a desire for lively agricultural-ecological landscapes.

In terms of territorializing of the assemblages, scientific knowledge and what Li (2007a and 2007b) calls “rendering technical” became major sites of re/deterritorialization, since science has symbolic authority, and power (Briggs and Mantini-Briggs 2016). A related field of re/deterritorialization is implementation of conservation practices, which when backed by or backing scientific authority, can achieve political potency. The desires and territories of the assemblages encouraged me to consider how a boundary object organized collective work from divergent entities, as well as how ideas, practices, and materialities in circulation also became sites for change and for assertion of authority.

2.4 Boundary Object

The concept of the boundary object emerged from the work of sociologist of science Susan Leigh Star and philosopher of science James R. Griesemer, specifically their analysis of a research natural history museum emerging in the early 20th century (1989). They build on the *interessement* and translation model of establishing scientific authority developed by Callon, Latour, and Law. This model proposed that entrepreneurs of a scientific concept would enlist participants/allies to their perspectives, reinterpret these ideas to fit their goals, and then become gatekeepers to those ideas (1989:389). Star and Griesemer find this too linear for the heterogeneity of science, which must account for scientific findings’ existence in multiple social worlds. Boundary objects are a set of processual and material work arrangements that resides between social worlds or

communities of practices where it is ill structured (Star 2010:602). Groups may then collaborate without consensus around this boundary object, where local groups make local, useful forms of the object that groups may then oscillate between. Boundary objects themselves are heterogeneous, abstract or concrete, and may take the form of repositories, ideal types, coincident boundaries, and standardized forms (Star and Griesemer 1989: 410-411).

At this point, I wish to clarify my use of infrastructure, which I discuss most in terms of the boundary object. Following Carse (2012 and 2014), I use infrastructure to mean the components of some system that facilitate particular kinds of work and interactions. Infrastructure then is the physical components of a drinking water utility that processes and delivers water. It is landscapes such as monoculture corn and soybean as well as restored prairie and wetlands. It is documents like the Nutrient Reduction Strategy that outline land management practices and watershed demonstration projects that provide technical and financial assistance to farmers and landowners with these land management practices (see Chapter 4, and Chapters 3 and 6). I also discuss potential and emerging infrastructure like various regulation on conservation compliance and the science around the nitrogen cycle (see Chapters 4 and 5). What all of these have in common is that they facilitate material and/or ideological work as well as relationships.

In Star and Griesemer's analysis, university administrators, amateur naturalists, professional scientists, patrons and other participants share the common goal of preserving California's nature through the collection of flora and faunal samples, which satisfies some of these participants as an end goal and others as a first step. California itself becomes a boundary object when the group proposes creating a nature preserve,

which satisfies the goals of various participants (e.g. one of the researchers would have a “field laboratory,” and the university would be serving California residents). Boundary objects inhabit two or more social worlds simultaneously, and this then is what makes them a boundary.

In my work, conservation as a boundary object is most in line with coincident boundaries. Coincident boundaries mean an object shares common boundaries but diverging internalities, developed through different data collections over a large-scale area. Despite these different kinds of work, the groups working have a common referent. Star and Griesemer (1989) define maps of California as coincident boundaries type of boundary object. Amateur naturalists included trails and campsites while professional biologists included ecological “life zones” of the state. The Iowa landscape in need of conservation is the object with shared common boundaries I use. Due to their diverging desires, actors in the corn assemblage and the prairie assemblage recognize common boundaries *and* infrastructure but focus on different aspects of it. For example, watershed projects are common infrastructures to achieve conservation, where farmers receive financial incentives and technical assistance to try different conservation practices. People could advocate for more cost-share on cover crops because cover crops can build soil fertility—a part of farm continuity—in concert with the corn assemblage, a part of farm continuity. Others might advocate for restored wetlands, which would support more biodiversity and a livelier landscape, fulfilling prairie assemblage desires. Both assemblages would recognize the value of both conservation practices but actors within them would show preferences for different ones depending on that practice’s effects on and for their desires.

Since Star and Griesemer's (1989) study, boundary objects have enjoyed engagement within multiple disciplines, particularly in design, planning, and the medical profession (Trompette and Vinck 2009). Because Star and Griesemer (1989) take an ecological approach, scholars have also utilized the concept in environmental research, such as the exploration of watersheds as a naturalized scale for neoliberal, scientific, and participatory action epistemic communities (Cohen 2012). Trompette and Vinck (2009) discuss the looser usages of the boundary object concept, where people use it for any object or mechanism through which translation and interaction occur. Specifically, they state the boundary object

...seems to have lost its original analytical momentum, i.e. the fact that certain objects or configurations – or even organisations – materialise and transport an invisible infrastructure made up of standards, categories, classifications and conventions that are specific to one or more social worlds.

Pointing out that Star (1999) pays attention to the infrastructure allowing a boundary object to operate, I consider the ways in which the conservation boundary object shares infrastructure allowing for circulation of knowledge and material practices across assemblages (i.e. my main substitute for their “social worlds”), such as field days, water monitoring, and the Nutrient Reduction Strategy (NRS), in response to Trompette and Vinck's critique (2009). Specifically, I integrate Star's consideration of infrastructure in my discussions of de/reterritorialization. I suggest that shifting the infrastructure of the conservation boundary object to serve their desires and local definitions is a major goal, achievement, and/or failure of each assemblage. Stabilizing and dissolving shared infrastructure then is a territorial strategy.

2.5 Circulation Studies

When considering a system of power/knowledge, most research has focused on production (STS) or application (political ecology). Overall, circulation has been treated as a mechanical process (for exceptions, see Tsing 2000 and 2008), even within impactful work such as Bruno Latour (1986, 1987), where he described “immutable mobiles” or objects (material and/or immaterial) that remain the same despite traversing through various contexts.

This dissertation is in part an analysis of how politics and knowledge infrastructure make certain objects more or less mobile. This kind of analysis aids in understanding the process of both boundary objects and assemblages. Both of those analytics focus on work/labor, movement of various kinds, and desire. Studying circulation can illuminate the ways in which these various processes happen and their consequences. Assemblage, with its focus on desire and de/reterritorialization, provides some of the language to describe circulation and movement. Similarly, boundary objects are achievements of the labors and interactions of participants representing different assemblages (often several), which also convey a sense of movement. However, I draw on Charles Briggs and his collaborators’ contributions to the study of circulation as a political and constructed process to enrich my analytic vocabulary and framework.

Briggs is critical of Latour and other scholars who have naturalized the processes of language production and circulation of ideas (i.e. the immutable mobile). However, Briggs also draws on work in STS, as in his research, circulation often becomes a matter of social justice. Broadly, I focus on the process of entextualization (Briggs and Bauman 1990). Entextualization is the process of decontextualizing discourse into a “text” separate from the interactions and contexts that produced the discourse, thereby

facilitating its circulation (1990:74). Additionally, entextualization considers how certain indexical (contextual) features may be foregrounded, placed in the background, or entirely erased in terms of creating mobility, in their case, of particular “stretches of linguistic production.” Entextualization follows Bowker and Star’s discussion of categories and standards in systems of classification (1999). They describe how, paradoxically, in order to circulate, the mobility of a set of categories requires both new, co-constituting and contextualizing relationships upon their arrival to a site of circulation in order for these categories to make sense in that new site. Simultaneously, in order to keep circulating, decontextualization must occur and certain aspects of the categorization system must be made invisible to make sense in new sites. While some recipients may be aware of the erased contexts and recover them, many others would not realize what they did not know. Classification here has political consequences as well, as these systems create hierarchies that benefit some and disadvantage others.

While studies of entextualization address the semiotic processes of making discourse into texts that are made to travel, the medium/media through which texts travel are also as important to consider. Therefore, I draw on Briggs’ additional concepts, communicability and communicable cartographies (Briggs 2007a and 2007b; Briggs and Mantini-Briggs 2016) to examine these dimensions. According to Briggs (2007a and 2007b), communicability is process of volubility (ability to spread) and infectiousness (degree of the spreading) of discursive texts produced by the mass media, all of which appears transparent and natural, but of course, required labor of decontextualizing and reconnecting these texts to new texts and genres. Communicable cartographies refer to the ways that texts represent their own origins, pathways of circulation, intended

audiences, and reception (Briggs 2007a:556). Briggs (2007b) discusses, for example, how news media stories reporting cases of infanticide in Venezuela, by convention, had only one acceptable narrative to write and for their public to respond to: a violent account of the horror of “crazy mothers.” Briggs’ interview with a young indigenous woman presented a very different narrative of desperation and marginalization that the media would not allow to circulate. Although related concepts, entextualization can occur in terms of any kind of circulation, while communicability is specific to mass media’s circulation efforts.

In their case study on communicative justice, Briggs and Mantini-Briggs (2016) explore the ways in which knowledge about a rabies epidemic that killed dozens of Venezuelan indigenous children was created, manipulated, and circulated by various participants—parents, medical personnel, and state officials—to privilege and obscure particular narratives and narrative forms. Drawing on Star, they discuss how everyone used the bodies of dying children as their boundary object, by which they tried to come to consensus about these dying bodies and through which the politics of knowledge and communication manifested.

Briggs and Mantini-Briggs (2016) utilize Peirce’s signification theory—a “sign” as symbol, index, or icon—to analyze how different people made and used knowledge around the boundary object of youthful, dying bodies. The symbol and symbolic authority indicates something established by convention and institutionalization, in their study, a diagnosis. Everyone understood and agreed upon the necessity of finding a diagnosis. Indexical relationships or calibrations described the projection of privileged points of knowledge making (i.e. the relevant contexts) and a person’s positioning of

themselves to these points. In their study, symptoms as well as disease origins became moments of indexical calibration. Participation frameworks refers to who speaks and who listens, who is legitimized to speak (“ratified”) and not (“unratified”) (Goffman 1981). Parents of dying children were unratified speakers, their *testimonios* of their children’s symptoms ignored, while doctors (of particular social ranks) were ratified to speak, as long as they did not confirm the politically unfavorable diagnosis of rabies. Finally, they discuss icons, in which a part stands for the whole, often conveying a sense of holism and truth. One of their examples of icons, specifically iconic transparency (i.e. the facets that make that icon seem more true and representative of the whole), was the accounts of the disease that mattered. Again, parents’ testimonials of their children’s illness did not become icons that went into the reporting of the disease, but the accounting of certain epidemiologists. Briggs and his team attempted to circumvent the typical institutional circulation of public health reports by going to the media, which would then report to the head of the state, with reports of rabies. However, the news media defaulted to the institutional gatekeepers, and the rabies was erased from view. Briggs and Mantini-Briggs (2016) provide a useful framework to consider how institutional gatekeeper authorities circulate information, dependent on the civil-state infrastructure that shape the relationship between power and knowledge.

Finally, I refer to the work of Rebecca Lave (2011, 2012) as a critical case study of circulation within a political ecology and STS framework. Lave considers circulation at ideological and political economic levels through an analysis of stream restoration science and methods, specifically the Rosgen Wars. Dave Rosgen, a consultant without academic credentials, developed the Natural Channel Design (NCD) method for stream

restoration. This method has gained widespread legitimacy despite the scientific communities' critique and rejection. Rosgen responded to the growing demand by state agencies for applied stream restoration methods with a standardized and simple set of practices, a common vocabulary, and short courses providing training for his method. In this case, state agencies rely on contracted expertise and seek easily scalable models to apply to degrading and degraded streams (i.e. in Briggs and Bauman, entextualizable models that do not attend to ecological particulars). Lave's attention to political economic factors affecting the constructing of expertise outside of scientific authority was instructive in my analysis, thinking about the broader forces affecting industrial agriculture and conservation in Iowa.

In sum, circulation figures into my work when I consider the discursive, semiotic, and political resources that various groups utilized to construct and manage knowledge about the origins of environmental nitrates, the pollutant-nutrients at the center the DMWW lawsuit and the NRS (see Chapter 5) as well as, to a lesser extent, the strategies of assemblage actors to bring their desires more in line (see Chapter 6). Nitrates are part of the knowledge infrastructure of the conservation boundary object. Finding their problematic origin could justify one local definition of conservation over another, privileging the farm or the prairie. Additionally, nitrates became part of re/deterritorialization efforts within the prairie and corn assemblages. Being able to claim knowledge of nitrate origins was one example of the work done to justify each assemblage's desires that created divergence between the assemblages rather than collaboration.

During my time in Iowa, two versions of a specific research study about nitrates—one implicating nature and the other humans—circulated, yet the former was more communicable and entextualizable than the latter. I documented similar discursive strategies that Comito et al. (2012, 2013a) discussed, such as active denial of knowledge connecting poor water quality and farming practices, equivocation of practices (e.g. lawn fertilizer had the same impact as agricultural fertilizer), and evocation of morality (e.g. the “hero feeding the world” role). However, the kind of extextualization deployed around nitrate knowledge represents a different kind of strategy for justifying ideological positions and material practices. It uses science’s symbolic authority to create a culturally salient narrative for agricultural actors and groups about farming’s role in water pollution. This goes against the common perception that science’s role is to identify universal phenomena, not legitimize culturally particular ones.

As will be discussed in chapter 5, what happened with the nitrate knowledge shows how circulation can obscure reality and create tensions. However, in chapter 6, I move beyond this finding to discuss how the assemblage actors tried to bring their desires together, merging definitions of conservation, through the infrastructure of soil health, water monitoring, and technologically-mediated landscape knowledge.

Both assemblage theory and boundary object aim to describe heterogeneity that allows for work to be done toward a particular desire/goal, with assemblage theory providing the framework to discuss the emerging social relationships and boundary objects providing the framework to discuss the labor and infrastructure within these social relationships and worlds. Circulation studies provide analytic tools to map the

movement of material and immaterial objects within and between the assemblage, and in collaboration around boundary objects.

2.6 Theory in Practice: Or, how a young scientist navigated the politics of her identity and relationships

This dissertation was also a Deleuzian assemblage, motivated by my desire to do good research—meaning ethical, honest, critical, and empathetic research. Science, politics, and emotions resonated with how I did my work as well as how I thought about my data. As a scientist, I felt uncertain and incompetent—the classic emotional symptoms of imposter syndrome. Grant rejections, discovering resources I did not know existed only after I was in the field, feeling redundant and unoriginal, having days go by with little activity—all of these added up to almost overwhelming doubt. I did not know how to present myself when doing research. Small decisions like whether to let someone talk uninterrupted or not and how much of my knowledge or perspective to reveal added to a complexly shifting researcher persona. I found I was not the kind of researcher who does not engage in conversation during an interview. However, sometimes I felt as if I was testing one participant while genuinely talking to another, and this difference in interaction unfolded largely due to my perception of a participant's politics.

From August 2015 through September 2016, I lived and worked in Iowa, traveling extensively throughout the state, and spending most of my time slightly east of Iowa City, around Waterloo (both in the Iowan surface), and in the northwestern part of Des Moines lobe (Figure 2.1). At the height of my fieldwork, I drove nearly 2,000 miles in a month to attend field days and conferences, meet for interviews, and volunteer. I spent a lot of time in my car, looking at farm fields, listening to audiobooks. As I developed rapport, people would kindly host me in their homes for days and weeks at a time, and I decreased

windshield time this way. I found my first hosts through WWOOF, an online database of organic farms seeking help and volunteers seeking room and board, and experience. After that, their friendships and my own introduced me to the incredible hospitality of eight families, who offered me a bed, meals, and a place to work all over the state.

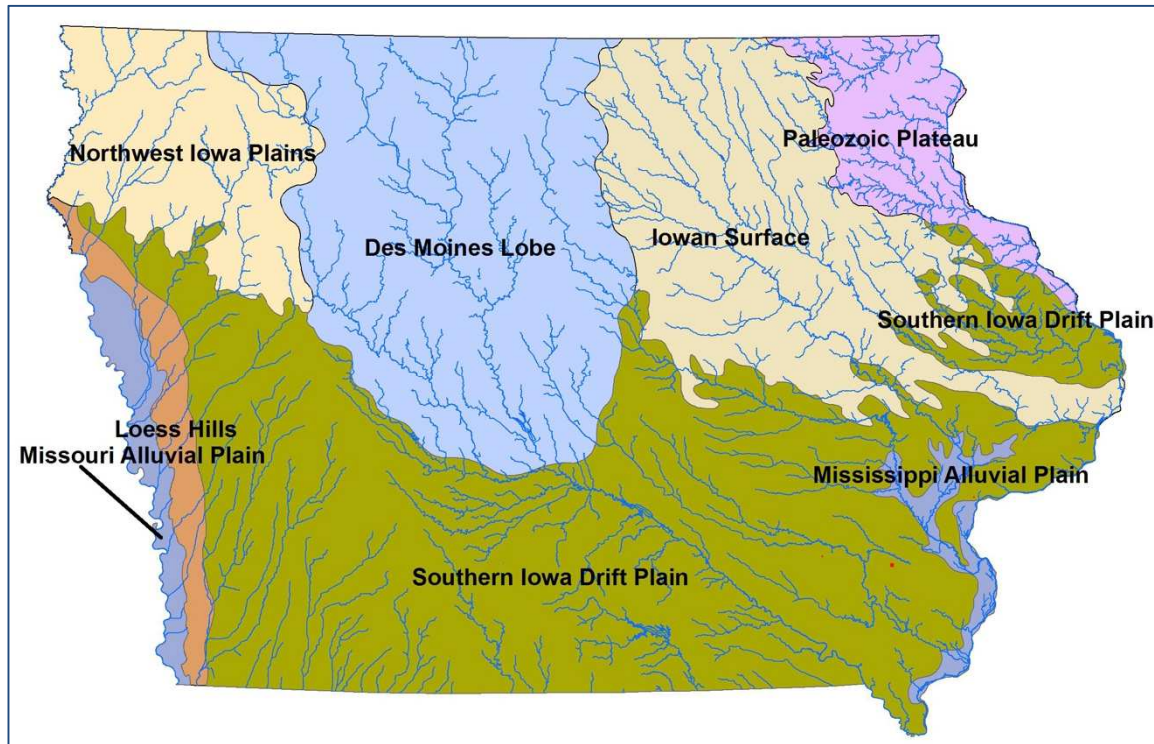


Figure 2.1 A map featuring Iowa's major geological landforms (Prior 1991).

The generosity I experienced in Iowa presents a tension within my work. Many of my research participants wanted to enlist me—a young researcher without a history in Iowa—in telling the story they believed needed to be heard. These stories and their truths were often in conflict with each other, and often with what I believed to be true. It was desire—both my own researcher assembled desires and those within the prairie and corn assemblages—that kept me sympathetic when my frustrations abounded over what I perceived as circulating misinformation, even lies (Chapter 5). A student asked me, after I presented my findings, if it was my goal to prove that people were lying or that science

was unreliable, which took me aback. I told her, no, I wanted to show how complex things were. Despite the desire to be objectively scientific, the worlds of conservation and farming in Iowa were deeply entwined with economics, politics, and socially sanctioned and rejected emotions. These worlds simply could not, and I thought should not, be separated. People's livelihoods and senses of themselves were at stake in these battles over knowledge, practices, and policy out on the landscape. Both desires within the assemblages made sense to me, and I often found the prevailing lack of understanding and empathy for each other's desires maddening.

2.6a Origin story and fieldsites

This dissertation as it stands now diverges significantly from my original proposal, a common but still disconcerting occurrence. Originally, I planned a multi-sited project, in Iowa and then in Louisiana, with travels to national conferences in the midst—a kind of mobile ethnography, touching down deeply and briefly at different sites. I wanted to follow the “hypoxia assemblage,” the actors and groups trying to shift Iowan land management practices due to their contribution to the hypoxic zone in the northern Gulf of Mexico. However, absence of funding and no prior connections within these fieldsites meant I underestimated the time and resources it would take to know a place. Six months in, I realized I needed to stay in Iowa longer to understand what was happening, and by nine months, going to Louisiana was no longer feasible. Additionally, I discovered that despite the connection between Iowa and Louisiana, hypoxia did not have organizing power on the ground. People would cite it in passing, and I'd be intrigued, but I found very different concerns had more impact than faraway hypoxia. Later, I would realize citing hypoxia demonstrated alliance, but not with Louisiana.

Instead people used hypoxia to emphasize that they supported the Nutrient Reduction Strategy, the voluntary approach, and collaboration rather than litigation and regulation.

In the late winter, I decided to keep the comparative spirit from my original project and document perspectives and practices between two very different watersheds in Iowa, the North Raccoon and the Middle Cedar (Figure 2.2). Des Moines Water Works was suing drainage districts in the North Raccoon watershed for polluting waterways with nitrates beyond the utility's technical capacity to clean the water. This lawsuit combined with a farming region was described to me as suspicious and not very conservation-minded. Much of the land was flat, characterized as dense and wet soil, with long cold springs. The soil is also some of the best in the state, only 10,000 years old from the last glacial till and enriched by prairie until the last century or two.

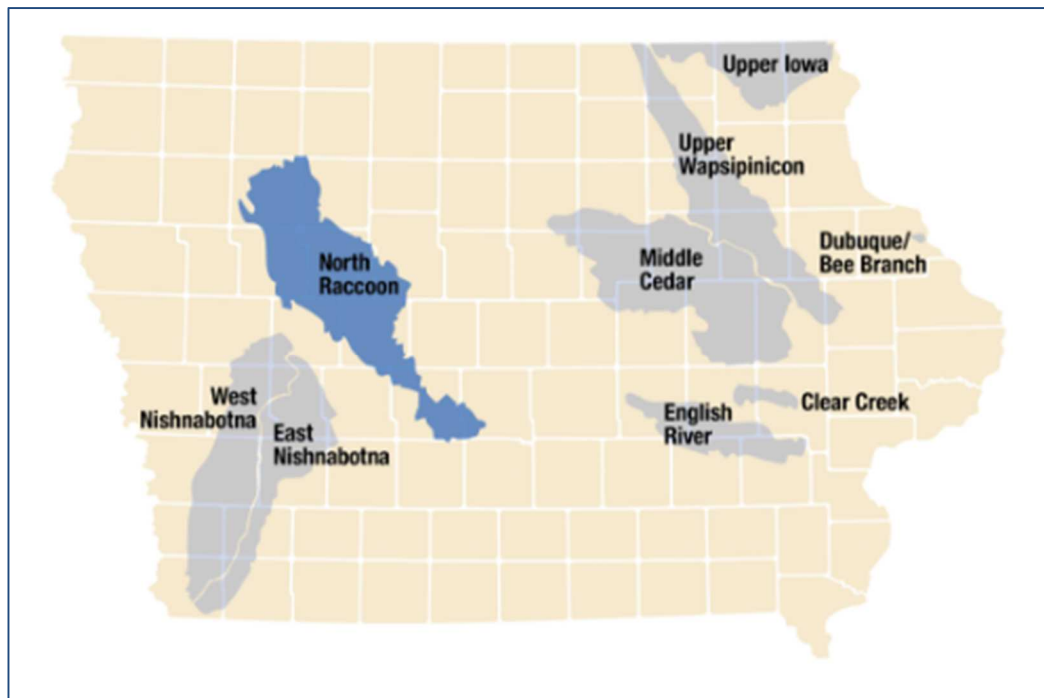


Figure 2.2 NRS Prioritized HUC8 Watersheds in Iowa (Iowa Watershed Approach 2017).

Farmers in this area often do corn-on-corn and raise cattle, a very difficult system for the landscape to sustain. In contrast, the Middle Cedar watershed had received many accolades for the grants secured and the collaborative spirit between local cities and farming regions. This land is still good soil, but hillier and warmer, with lots of seed corn acres. The not quite as good status of the land encouraged conservation practices and more farmers had terraced their farms to prevent soil erosion as part of conservation compliance for the 1985 Farm Bill. I spent the last eight months of fieldwork traveling between these two places. I could feel the difference. The Middle Cedar had multiple industries and surviving small towns; it bustled with activity. The North Raccoon was more isolated, a feeling of being emptied out, with the promotion of rivers and lakes trying to provide recreation and beauty in the landscape. Despite this difference in landscape and farming practices, in my dissertation I focus on the similarities rather than the differences between my research participants in these two regions. While I did notice more defensiveness in some responses to my interview questions on the part of both farmers and conservation experts in the North Raccoon watershed, I was more interested in how ideas did not necessarily connect to practices or place for my research questions.

2.6b Researcher Positionality and Research Participants

My adviser asked me half-teasingly, half-sincerely, why I had chosen this topic and this place out of all topics and places. What my adviser meant was much of my time was spent with a group of people, on principle, I found difficult to understand and therefore worthy of study: politically conservative older white heterosexual men.

However, the truth was that I did not realize how difficult this research would be for me emotionally and scientifically, as I navigated unfamiliar politics. While I have lived in the southeast my whole life, I came of age surrounded by politically progressive and liberal

people, with only brief encounters with conservative ideologies. Additionally, while people in and outside of my fieldsite tended to direct my focus to farmers (aforementioned older white men), I worked with other groups of people, which made my position in the field more complicated but less fraught.

According to the US Census Bureau, there are 3,145,711 people living in Iowa as of 2017. I sought out research participants by their occupation (Tables 2.1, 2.2, and 2.3). I wanted to speak to row crop commodity farmers and people who were professionally involved in soil and/or water conservation in some capacity. Primarily these conservation professionals were SWCD commissioners, NRCS and IDNR staff, watershed project coordinators, although I also spoke to drinking water utility staff, conservation consultants, other conservation agency members, university researchers, and environmental advocacy representatives. If multiple people told me someone would be good to talk to, I generally tried to connect.

Table 2.1 Farmer Demographics

	Middle Cedar (n=13)	North Raccoon (n=13)
Average age	47	63.5
Has kids	90%	90%
Education after GED	84%	92%

Table 2.2 Conservation Expert Demographics

	Middle Cedar (n=8)⁹	North Raccoon (n=9)
Gender	1 woman 7 men	4 women 5 men
Average age	54	56
Has kids	63%	89%
Education after GED	100%	100%
Farm Bureau membership	12.5%	11%

⁹ Several farmers were SWCD commissioners, so I interviewed them as conservation experts and farmers but included them in the farmer demographics.

Table 2.3 Farm Operations Averages

	Middle Cedar (n=11)	North Raccoon (n=10)
Livestock	63% [18% hogs]	60% [50% hogs]
Tillage (use some no till)	55%	20%
Average acres owned	295	644
Average acres farmed	1941	789
Off farm income	18%	40%
Farm Bureau membership	70%	80%

I did not consider other important social positions such as gender, race, ethnicity, or social class, although acres farmed can be a part of an indicator of social class in Iowa. In terms of the racial demographics of Iowa, 91.1% of people identify as white (85.7% as white, non-Hispanic), 6% as Hispanic or Latino, 3.8% as Black or African American, 2.6% as Asian, 0.5% as American Indian, 0.1% as Native Hawaiian, and 1.9% as biracial or multiracial (US Census Bureau 2018). Whiteness is so pervasive in Iowa that describing someone with any other racial identity would be too identifying, so I do not address race to protect the anonymity of my participants. Although gender plays an important role in current topics on conservation in Iowa, it did not factor into my main research questions. I only spoke to a handful of female primary farm operators and several farming couples, although in these interviews of parents and children or spouses, the man tended to do most of the farming labor. Among my conservation experts, women were more represented, but again this did not factor into my research questions.

In addition to the people I spoke to, the landscape of Iowa itself played a vital role in how I addressed my research questions. Iowa land is primarily in agricultural use, and this fact has implications for how power works in the state, specifically that most of the land is privately owned and part of economic livelihoods dependent on the world market

(Table 2.4). Private ownership of the land affected the relationship between the conservation experts and farmers in my research.

In terms of my participants' relationship to me, what mattered most about me for my research participants was that I was not Iowan and did not have a farming background. As I made cold calls for an interview project I did for a local conservation group, my out of state area code likely made most farmers disinclined to pick up. Even a farmer I knew well would answer with hesitation and evident distrust, laughing when he realized it was me, not a telemarketer.

Table 2.4 The Iowa Landscape¹⁰

# of Acres in IA [including rural, developed and public land and surface water]	36,016,500
# of Acres Farmed [as of 2017] (USDA NASS)	30,500,000 (84.7%)
# of Acres of Cropland and Pasture [as of 2015] (ISU)	29,072,700 (80.7%)
# of Acres in CRP/Wetlands Reserve Program [as of 2015] (ISU)	1,030,600 (2.86%)
# of Acres of Publicly Owned Land [as of 2015] (Trust for Public Land)	240,404 (0.667%)

Research participants could not figure out why I was there. They tried to place me. Was I affiliated with Iowa State or University of Iowa? Was I originally from Iowa? Did I have a farming background? Was I connected to Farmers in the area? My interest in the topic was acceptable but not enough. This un-placeable aspect peaked people's curiosity and suspicion of me. They asked me, "Why Iowa?" as much as colleagues and I did. In many ways, I blended in; I was a young, white, femme-looking woman. My strange buzzed haircut grew out, and the need for layers usually covered up my unshaven

¹⁰ Table compiled from data from ISU 2018, Trust for Public Land 2018, and USDA NASS 2018.

legs and inclination to go braless. Depending on my research participant's politics, they assumed different things about my own perspectives. Sometimes they'd assume I was ignorant, or a liberal environmentalist activist. Other times, they assumed I meant to report something they would not like. Finally, they'd assume I was someone like them. Once, an older former state legislator and farmer, Melvin, interviewed me before I could interview him to evaluate these various possible positions. I was taken aback, saying, "Is this necessary?" He drawled, "I just want to find out who I'm talking to." He asked about my opinion on hog confinements, climate change, and GMOs. I answered as honestly as I could, and we proceeded with our interview. Other times, farmers would explain certain ideas to me, and I would hand them a survey I had created. The survey demonstrated I had a good understanding of many of the topics, and this often led to a little bit of discomfort or uncertainty in our final interactions. "I see I don't really need to explain this to you." "Will I have any say in what you publish about me?" A conservation expert cornered me at a conference, and said he'd be very interested in hearing about my research, with such intensity I asked one of his colleagues if I should be concerned. She said, "Since things are fragile and tense, he doesn't want any additional problems."

I struggled sometimes with how to be during fieldwork. Research participants would ask if I would marry an Iowa farm boy, usually in a playful manner signaling that they liked me well enough and thought I should stick around. Other times it was uncomfortable and bordered on and into sexual harassment. Being LGBTQ and in a relationship at the time was not something I shared with many people in Iowa, especially not participants I expected to be more conservative (re: farmers). My relationship was a source of joy and stress, so editing my conversation to exclude my former partner became

exhausting. However, when I met people who expressed more liberal views, I found myself opening up, about who I was as well as what I believed. Many times, I'd ask friends and participants involved in conservation and small-scale agriculture what they thought about certain issues that baffled me. "How can farmers say they are feeding the world? Isn't that just lying and hubris?" Sometimes I was this candid with corn and soybean farmers, but I expressed it more carefully, often as, "People have told me this. What do you think?"

The main issue with my positionality was that research participants saw me as a potential ally. I could tell the truth, whether that truth be that farmers were doing their best to address nutrient loss or that farmers and farm groups were maintaining the status quo of production agriculture with deep costs to conservation goals. They just had to convince me of their truths. Due to my outsider status, people expected that I had more freedom to tell their stories. Several times, university scholars told me because they worked with farmers and farm groups, they did not feel they had the academic freedom to approach topics in certain ways, or at all. They thought I could address directly and explicitly the politics framing their research in ways they could not. Yet, like me, they had friendships or at least relationships of respect and care. Granted, other scholars scoffed at this perspective and said they did what science required, tell the truth. Yet this hesitancy I witnessed spoke of a deeply troubled relationship between scientific truths and agricultural realities.

2.6c Methodology: Data collection & analysis

I considered my data collection a kind of "middle ethnography," since I was inundated in Iowa culture for thirteen months, and yet I did not live and work daily with my research participants. I did not see my work as focusing on a community that shared

geography and culture but more on a social problem: agriculturally-derived water pollution. This meant I went to sites where the problem was advertised and discussed, and to the people who were implicated and involved in addressing this problem.

I did participation observation at multiple events, including field days (informational sessions hosted by conservation and ag groups about practices, technologies, and programs), conferences, farm and conservation group meetings, water quality data collection events, and cultural events like plays and tractor rides. A kind farmer bought me an hour in a tiny plane to see the county from above. I volunteered with farmers and watershed project coordinators, helped plant, stuffed envelopes, documented tillage across counties, and collected water samples in order to immerse myself into the materiality and labor of the landscape. For one watershed project, I did interviews in the area to explore how local farmers thought the project could increase participation. I spent time crumbling soil in my hands, figuring out what “mellow” soil meant, looking at its structure and interlacing networks of roots, searching for nightcrawler and earthworm holes. I put solutions and chemical strips into tubes of stream water to test for nitrate/nitrite, phosphorous, dissolved oxygen. I learned the names of dozens of prairie plants—compass and cup plants, blazing stars, coneflowers, gentian, milkweed, and my favorite, prairie smoke—and got pretty good at identifying them. I rode in combines during harvest and tractors during planting. I also became quite fluent in farmer speak; I could navigate their conversations about chemicals, grain prices, farm programs, machinery, and the rhythm of farm activities. All of this work was interspersed with extensive driving—past bare ground and occasional green cover cropped fields, past hog confinements and wind turbines, past creeks lined with buffers

and others without, an alongside hills and on roads lining up with the cardinal directions perfectly. I also had long periods of guilt-ridden inactivity. Luckily, I often lived on farms so I worked in the gardens when I became exhausted with the paralysis and guilt.

I also interviewed, semi-structured and unstructured, a lot of people (see Appendix A and B for final interview guides and Appendix C for invitation letter). I audio-recorded the majority of them. For my comparative sample, I conducted 40 formal semi-structured interviews in my two different watershed fieldsites with two different groups: corn and soybean farmers and conservation experts. While they shared some characteristics, these were somewhat etic categories (especially “conservation experts”), and I observed considerable variation within those groups, which I discuss throughout. Outside of those 40 interviews, I also conducted around 60 formal and informal interviews with NRCS staff, SWCD commissioners, watershed project coordinators, DNR staff, NGO staff (such as the Nature Conservancy and other local advocacy groups), small-scale diversified farmers, corn and bean farmers outside of my primary watersheds, environmental activists, politicians and lobbyists, and university researchers. Finally, I interviewed 14 farmers using a semi-structured format for the watershed demonstration project as part of my volunteer work with them. The interviews allowed me to meet the many people who were involved in water conservation and agriculture for their work, livelihoods, recreation, and activism. Often the interviews were one-offs, with people who had never met me before, and I had contacted them because someone else had told me about them (snowball sampling) or I had met them at the events I attended. Occasionally, the interview occurred after I had rapport with the person, or the interview would spark more interactions. These interviews often were accompanied by riding

around in trucks or four wheelers to see the land. Generally interviews lasted for an hour to hour and a half; my shortest interviews were 40 minutes and the longest one was over 4 hours. I enjoyed interviewing but came up against its limitations in the end. By the end of my 40 comparative interviews, I felt I could often predict the answers to my questions; I had hit sample saturation.

Halfway through fieldwork, I designed a paired comparison survey based on participation observation and ethnography (see Appendix D for full survey). The questions looked like this:

Water quality in Iowa is
improving **or** worsening
worsening **or** staying about the same
improving **or** staying about the same

I received 24 completed. It was most interesting to watch people fill these surveys out. They would often talk to me about the question, shake their heads, or ask if they could skip certain questions. While the data itself may not be particularly useful, as a method for discussion, the surveys yielded fascinating interactions between participants and me.

My data set includes fieldnotes, mainly descriptive but also methodological and analytic; audio of interviews and several meetings, as well as interview logs and transcripts; photographs and video footage from different events; lots of literature (brochures, reports, articles, agendas); hundreds of emails from several farm and environmental group listservs; and 24 surveys. This dissertation focuses on my fieldnotes, the 40 comparative interviews, analysis of news media articles before and after the lawsuit, with insights from some of the other 74 interviews and key documents collected from different fieldsites.

For analysis, I organized all textual data generated from my research into MAXQDA, a qualitative data analysis program. Since many of my interview questions elicited oral history-type responses, and many organizational documents contain stories about resources as well as institutional histories, I utilized narrative analysis for materials eliciting stories (Riessman 2008). Since I also examined how certain discourses may get used in hegemonic ways, such as about conservation and non-point source pollution, I used critical discourse analysis (Fairclough et al. 2011). Finally, I used a coding scheme that effectively operationalized Briggs' (2007a and 2007b) concept of communicability to discuss how knowledge circulates and the material and immaterial effects of this circulation.

2.7 Concluding Remarks

In this chapter, I have discussed the theories and methods I have used to address my three overarching themes: relationships, variation, and power. Research on industrial agriculture must take into account scientific knowledge as well as natural resource conservation as co-constituting, keeping in tension the political infrastructure and on the ground experiences. My three themes are ways to do that, particularly with a focus on relationships and variation, and building on past scholarship attending to power within the industrial agricultural system. In order to discuss a globalized, globalizing, and matter-of-the-state system like industrial agriculture that has far-ranging ecological and social consequences, I needed a framework with the analytic power and breadth of political ecology, which at its best, deals with multiscalar politics as well as ecological and technological entities. Posthumanism gives insight into variation, that even within ideas and realities like monoculture, the lives of humans and nonhumans in these settings can follow different trajectories and consequences. STS, at its best and particularly in

combination with political ecology, can demonstrate how relationships interact with politics around knowledge infrastructures. The assemblage, boundary objects, and circulation studies provide the specific analytics to consider all three of my themes, as the subsequent chapters demonstrate.

Finally, I recognize I was as much a player in the themes I describe throughout this dissertation due to my researcher position. I am a scientist—with my own politics and my own interpretations and ability to be interpreted—who relies on the relative acceptance of people to do my work. I have aimed to speak truth to power, but it has not been without trepidation. The people of Iowa I encountered were overall extremely generous to me, and it was variation that drew me to Iowa in the first place, because I could not imagine industrial agriculture to be as monolithic and homogenizing as some literature made it out to be. As scholars have investigated variation in systems like capitalism, even capitalisms, I felt in my gut the same must hold true in Iowa industrial agriculture. Additionally, I find the power some groups—the state, certain farm groups, and other groups and individuals with money, status, and authority—to maintain the status quo of industrial agriculture frightening and disturbing, and have felt some reluctance to be entangled with it. Thus, with these conflicts, convictions and uncertainties, I can begin telling the story of my time in Iowa, where I did research, cared about the people and the place of Iowa, and grounded truths.

2.8 Embedded appendix: Advice to students doing fieldwork/in-depth research

This section is mainly my attempt to convey some of what I learned to other researchers, students such as myself and perhaps mentors. This is what I wish I had known or known more deeply, and practiced in the field. There is much more to consider,

particularly for those doing international research, so talk to colleagues who have experience with research abroad.

1. Do a pilot project if at all possible. Network with other researchers and gatekeepers within your fieldsite and ask lots of questions to help guide your project proposal.
2. Look outside of your discipline thoroughly to see what kinds of research has been done in your fieldsite/on your topic. Sociologists have done lots of work on the topics I was interested in, and reading it beforehand would have benefited me greatly.
3. Apply for grants early and often. Go to grant writing workshops; many graduate schools have these resources. I often found my second iteration of a project proposal went much further in the selection process but not far enough. Reviewers for grant agencies will also point you to potentially useful literature.
4. Do not forget that you should have a life outside of research during fieldwork. It was difficult for me to make friends for a number of reasons. I was not planning to be in Iowa long, so I felt overwhelmed with work I needed to do. Making friends sounded exhausted between the short amount of time and my workload. But I was more productive when I took breaks and did fun and/or social things. I learned something different about my fieldsite, and my brain got to take a break. This has been my most lasting lesson, hard to remember in the midst of stress and uncertainty, but allowing myself breaks were what facilitated my most productive periods of research, including writing this dissertation.
5. Take methods courses. In your university, across disciplines. The AAA has a methods mall with courses and field school options.
6. Keep a personal journal. I had several ways of keeping record and notes (descriptive, analytic, and methodological), but a journal to emote was so important.
7. I found note-taking exhausting but vital. Figure out ways to make recordkeeping less burdensome. Caption photos in detail. Draw. Work with dictation software. The last thing I wanted to do was stare at a computer after attending an event or doing an interview, but at this end of my dissertation project, my notes have been useful sources for analysis and recall.
8. Play around with a data management system early. Keep logs of what you are doing. Pick a data analysis software.
9. Log or transcribe your audio files in the field if you can. If it's too overwhelming, it can wait.
10. Most importantly, remember this is a learning process. You will figure out how to do research as you go; you do not have to know everything now.

CHAPTER 3

WELCOME TO IOWA

I'll put that black Iowa dirt on a biscuit,
I'll put that black Iowa dirt in my tea
When they go to fill my grave on the hill
They'll put that black Iowa dirt over me

I got that dirt underneath my fingernails,
I got that dirt runnin' through my veins
that black Iowa dirt turns my blood to mud
every time it rains

- from "Black Iowa Dirt" by William Elliott Whitmore and Jenny Hoyston

In this chapter I explore the worlds of agriculture and natural resource conservation in order to introduce the human and nonhuman actors—agentive, living, vital, companion, and otherwise—that matter in the becoming of what I call the prairie assemblage and the corn assemblage, which I introduce in more detail in the following chapter. By describing the actor-participants in the assemblages, I am able to accomplish the following. First, I lay the groundwork for my discussion of the conservation boundary object and the invisible and visible infrastructure shared to work for and around this object. Second, this description introduces the actors, entities, and vital technologies of the assemblages, their desires, and their work around the conservation boundary object. Finally, I give an introduction to the circulating (or not) knowledge and practices that make a difference to the content and labor of assemblage desires, as well as progress and failure for the boundary object. For each aspect of the landscape I explore—corn and soil, water and tile, and cover crops—both assemblages include them yet orient differently

around them. For example, drainage tile makes acres workable for farming and watersheds in need of conservation work, but tile is a shared infrastructure between the assemblages. The assemblages then take these actors in divergent relationships and apply them to a desire.

First, I consider two kinds of scaling projects in Iowa: acres and watersheds. I discuss how these spatial categories are made through social relationships and techniques of comparison, with political consequences (Barnes 2014; Carr and Fisher 2016; Carr and Lempert 2016; Sneddon and Fox 2006; Strathern 2004; Swyngedouw 1997 and 2004; Tsing 2000 and 2008). I follow scholarship that denaturalizes scale as a bounded category, relegating global to the abstract and detached, and local to the communal and participatory. Instead, I consider how scale is fluid and emergent, socially constructed, and doing work, specifically attending to the goals of scalar projects (Tsing 2000). For example, a farmer reported to his local Farm Bureau on his participation in federal lobbying for the Trans-Pacific Partnership, an international trade deal. These multiple scales—often considered separate—are present in one interaction. I also discuss briefly different spatiotemporal scales of great significance in Iowa, including the geologic time scale (the 10,000 year old glacially tilled soil, new and fertile from prairie), and human time scale (first inhabitants of the prairie, groups such as the Ioway [for an indigenous history, see Foster 1999]; European colonization beginning in the early 1800s and their resulting agricultural histories).

Second, I highlight the actors in these scale-making projects within Iowan farms and Iowan waterways, specifically focusing on corn and soybean monoculture as well as the relationship between agricultural drainage tile and rivers. I then discuss cover crops as

an intersection of these worlds, as cover crops aim to fill in the gap, providing agricultural and ecological benefits. Finally, I discuss how certain materialities expand and contract the potential of the landscape by exploring livestock and crop diversification and nutrient-focused grants. Through these descriptive movements, I aim to demonstrate the variation within the categories such as farmer, farm, conservation expert, and conservation project. This chapter also lays groundwork for understanding assemblage desires, which I discuss in chapters 4, 5, and 6.

3.1 Scaling Iowa

As a place, Iowa felt large and empty to me. Outside of the few cities and their encroaching development, Iowa was enormous skies uncut by trees or houses and rolling fields of corn as far as my eye can see. Within natural resource conservation and agriculture, two ways of making sense of the landscape were through the units of acres and watersheds. In this section, I describe how the scale of acres and watersheds were made more so through social relationships rather than naturalized spatial boundaries.

Scholars have denaturalized scale as a bounded, spatial concept that moves between small and large, local and global. Multiple disciplines have explored the social construction of scale, particularly cultural geography (for example, see Swyngedouw 1997 and 2004). I first use scale to consider the methods of comparison that construct the concept of “large-scale farming operations” in acres, and the social relationships embedded in this comparison. Then I explore the power dynamics that have put watershed in place as the appropriate scale for conservation. Considered together, the watershed approach is a scaling down, a localization of conservation, while the largest operations is a morally problematic scaling up. However, the watersheds that become

conservation projects are generally two to ten times larger than the moral boundary of the “too big” farming operation—10,000 acres.

3.1a Industrial farm acres

The acre—roughly the size of a football field—is a common unit of measurement in Iowa. While used for other purposes beyond agriculture, for housing and development as well as conservation, acres of a farming operation were a sensitive and personal topic, conveying the social class as well as perceived morals and ambitions of the farmer. European colonial settlers claimed 80 acres as part of their homesteading farm projects in the mid 19th century. When I met farmers during my fieldwork, often their operations were multiplications of 80, enabling me to imagine how many families had originally farmed what one farmer did now. Additionally I learned a farming operation was different from a farmer’s homestead. Many of the farmers I met owned or farmed land throughout the county and even across county lines. “The farm” then was not a spatially continuous piece of land but rather created through the social relationships between a farmer and landowners. A neighboring piece of land next to a farmer’s homestead may only come up for sale once in a farmer’s lifetime, several farmers told me, so they would try to wrangle as much capital as possible to secure it. At one auction I attended in southwest Iowa, 80 acres with a CSR of 70.9¹¹ went from \$10,250 per acre (Figure 3.1). I asked the wife of the winning bidders (who had looked increasingly crestfallen with the climbing price) why they had been willing to pay so much for mediocre land. They had been farming this land for a while, which was adjacent to their own operation with pigs. The inheriting son sat nearby, and my friend Katharine wondered why the son and couple

¹¹ 90 to 95 CSR is very good land, so this score of 71 was fairly average.

had not sat down to figure out a fair price. I heard many stories of the bitterness coming from land sales and renting arrangements.

Knowing then the intense emotional connection between land and farming, the size of an operation carried implications for perceived morality of a farmer. The enormous size inspiring Jane Smiley's novel *A Thousand Acres*, taking place in the 1970s, now would be considered little more than a hobby farm. Austin, a conservation expert, told me that where he came from 400 to 500 acres was the largest farm, and even the equipment here was three times bigger than what he had seen growing up in the South. In other words, how a farmer would evaluate the morality of other farmers was relational, dependent on the size of the evaluating farmer's own scale of operation: how many acres they owned, how many acres they rented, and most importantly, how many families the operation supported. However, I did find the upper limits of morality. At 10,000 acres, people started to talk, the exact number a hushed subject of gossip, and the wisdom and morality of this large size was questioned.



Figure 3.1 At a farm auction, participants and observers

Whoever farmed the largest number of acres in a county was a touchstone in our conversations, a way to distinguish personal morality from this looming neighbor pushing their operation beyond the idea of the “family farm.” Yet in several cases, these 10,000-acre farmers were cited as doing the most in terms of conservation practices, in part due to the perceived (and real) social scrutiny.

Typically, farmers would dance around bald-faced moral judgment of the largest scale operations. “I don’t understand how you can do a good job with 10,000 acres. Not that they are bad farmers exactly; they just can’t pay the attention necessary with that many acres. Every farmers knows his operation best,” one farmer told me. Few were as direct and clear as Andy, a corn and bean farmer (“with four chickens”). He and his wife spoke to me about wanting their son to take over their farm, and how “big” farmers impacted that.

I’d say a big guy is someone who is having to hire a lot of people to help. You may farm 100 acres, but if you have to hire people, that means you’re big... maybe 2500, 2000. The small guys, I wouldn’t consider myself a big farmer. My brothers and I have about 800 acres each. But some guys think we’re big since we have more than one combine and share equipment... I don’t understand how if you can make your living off a certain amount of ground, why you’d keep getting bigger. I wouldn’t want to deal with that. Then you have to hire people...

You know, they [beginning farmers] might be in their 40s trying to get in, and if the young farmers can’t get in, the others just get bigger. Most guys are older than 61. I want to see these young guys get a chance. But if you make a little mistake, then it’s over. Students already got debt, then you have to go into more debt to farm. Then farms go to these big guys.

In this discussion, Andy defined large-scale in terms of hiring non-kin labor. So an operation could support family by blood, but not necessarily other families in the county in order to be considered morally appropriate. This showed in how several large-scale farmers explained to me they ran a family business, working with siblings and/or

children, but also treating their employees as family, often because they had known these employees throughout their lives. Andy provided an alternate definition for “large operation” by considering the amount of machinery, which could include his operation, shared with his brother. Planting season, as I will discuss, is a stressful period with often small windows of opportunity due to weather and the length of time the crops need to grow well. A large amount of machinery could help explain the ability to farm so many acres, but the hired labor was typically seen as less conscientious than familial labor. Finally, Andy showed the moral boundaries that go along with large scale operations: their success means the lack of opportunity for and even failure of young and beginning farmers. This, I learned, was the most significant critique.

Speaking to several farmers operating with 10,000 acres, I saw in action this moral pressure. When I asked how many acres they farmed, they would pause, asking if this information was confidential. Edwin, a farm manager, took me to meet one of his friends, the largest producer in the county. Edwin said it was rumored they had 10,000 or more acres. He also said the family had lost a son in a tragic accident, a curious but perhaps humanizing fact given to soften or complicate my opinion. As I rode in Greg’s combine, he tried to put on as friendly a demeanor as possible, but a field of down corn, leaning over due to wind damage, put him in a foul mood. I was just sorting out my interview guide at this point, and asked him about his acreage, not fully understanding how personal this question was. Silence filled the cab, Greg looking straight ahead. He quietly replied, I don’t typically share that information. I looked around me in the cab of the combine, one of the nicest I would ride in, and the enormous shining grain bins a mile or two away from the field we rolled through. I knew what Edwin told me must be true

then. Edwin showed me right after my combine ride how to read a farm's wealth by looking at how many (new) pieces of equipment were out, and how large and new the on-farm grain bins were (whereas other farmers had to truck the majority of their grain immediately for storage elsewhere). Up to 6,000 to 7,000 acres, farmers would share this information with relative ease, often justifying the large size through its supporting at least two families.

How did farmers own and rent so much land? Only a few willingly admitted to me that while the 1980s farm crisis devastated many, it had helped their operations, as land went up for sale cheaply when other farms went bankrupt. Many of the farmers I spoke to, however, had smaller operations and had survived the farm crisis by not having too much debt or through deep struggle.

The justification for this moral boundary over acres now—when in the past former Nixon administration Secretary of Agriculture Earl Butz said “Get big or get out,” the moral imperative of capitalism at the time—people like Andy cited the effect these large land holdings had on young and beginning farmers. Young and beginning farmers were the ultimate moral trump card. If it benefited beginning farmers, that was good. If it affected them negatively, it was bad. Despite much discourse around young people (especially Millennials) and my generation's poor work ethic, the crisis of the aging Iowa farmer and farm transition struggles made the future of who would farm the beautiful Iowan soil to produce beloved Iowan corn remained a paramount and difficult question. If young farmers did not have access and could not afford competitive rent prices like 10,000 acre farmers, their work ethic would not matter.

Popular critiques of industrial agriculture rarely include the extent of the renting versus owning land problem. In Iowa, however, the complexity of this issue is well known. Property rights guaranteed care in the minds of most people. Yet who owned it in order to care made a difference. When farmers owned and farmed land, it was easier to make risky decisions. Typically, I saw this with retired farmers who were interested in conservation and were able to make sure their tenants planted cover crops, used no till, or did other specific practices.

Renting was more difficult to assess, and the majority of farmland is rented in Iowa (Lyman 2017). For some farmers, particularly in very competitive counties, renting a parcel came with no guarantees that they would farm it the following season. They expressed two strategies to me to deal with this uncertainty. Some farmers used the bare minimum of inputs—fertilizer and pesticides—to save expenses. This occurred more often in a cash rent system, where the landowner did not receive any of the profit of the corn or beans, but they also did not pay for any of the inputs (versus crop-share, where inputs and profits were shared). In this type of relationship, farmers rarely described their own strategy as this but rather, with disgust, the strategy of more cutthroat neighbors who “raped” or “abused” the land. Other farmers tried to guarantee access to that land by treating the land as if they owned it, hoping to solidify the social relationships through a material relationship with the land. My 10,000 acre farmers often expressed this view and updated their multiple landowners on their operations regularly. The wife in one operation did brochures, with family members and employees writing short updates and op-eds, even recipes, that were distributed to landowners. Landowners could both facilitate and impede the ethics of care in farming. Programs addressing women

landowners have become popular to draw on gendered expectations of care (see Carter 2015). Alternatively, absentee landowners often inherit farms, and spatial and emotional distance from the farm generally made the primary goal to receive the highest rent.

Rather than simply looking at the size of operations as moral boundaries, I found that the land ownership and social relationships mattered just as much in determining the consequences of scale. Additionally, the scale of an operation could be made smaller or larger depending on comparison.

The relationality between land and farmer had significant implications for the concept of the “family farm.” In addition to the conflicting and vital ideological roles of farmers as stewards, entrepreneurs, and heroes (Comito et al. 2013a), the family farmer was a critical moral boundary and role. Iowa has a state law that farms must be owned by families, not corporations, although this has become complicated with the introduction of LLCs (Limited Liability Company) and other ways farms have been structured to act like corporations. While families may own the farming operation, increasingly agriculture has relied on non-kin relationships to satisfy employment and operational needs (i.e. renting from non-kin landowners). The family became naturalized as the best social unit to run the farm, and this law obscured the messy reality and increasing corporatization occurring within crop agriculture.¹² Acres then became a matter of the preservation of the family farm, a source of pride and nostalgia in Iowa that lauded the families who had “century farms.” It was not that 10,000 acres was so large it undermined many farmers’ ability to imagine good ecological stewardship but that 10,000 acres did not meet the family farm ideals. Hired non-kin labor, multiple pieces of equipment like tractors and

¹² I discuss how the livestock sector is already a corporate enterprise in Iowa later in this section.

combines, and investment in conservation practices all made large-scale operations capable of farming to conservation and entrepreneurial standards, but it did not meet the social standard of being an operation run mainly through blood relations. A large-scale operation may have more people working per acre than a 6,000-acre farming operation run by two or three family members, decreasing the number of acres each person was responsible for. However, it became large-scale not because of the amount of work or number of acres necessarily but who did the work. This importance of the “family farm” demonstrates that scale was not simply a matter of size but of social relationships. In this instance, the morality of scale was negotiable, coming down to how farmers intended to maintain their operations, through social relationships or through independence and self-reliance.

3.1b Hucks and watersheds

Watershed is the scale serving as the boundary for many conservation projects. Like the family farm, watersheds have been naturalized as the most logical unit through which to do conservation work (see Cohen 2012). A watershed indicates the area of a land that drains to a common source and, in Iowa, the land of a watershed was measured in terms of acres. The USGS divides various scales of watersheds using HUCs (Hydrologic Unit Code), although a HUC does not always constitute a complete watershed. HUCs deal with number of acres, so if a watershed is too large for the next level of HUC, often it is divided into upper and lower sections. The state of Iowa designated nine priority HUC8 watersheds, which were eligible for additional funding for conservation demonstration projects. Watershed projects are generally composed of one or two HUC12s (10,000 to 40,000 acres, or slightly smaller than a township).

Watersheds transcend traditional political boundaries since they do not parallel

county lines but follow supposed natural ecological lines (Cohen 2012). The idea of a watershed project challenged typical ways Iowans would associate themselves to the land. Watershed did not denote a community, nor would people identify as members of a watershed in the way they identified with their county. Instead, it was ideally a shared relationship with water. However, consider conservation expert Maya's comment, "The people in this watershed don't want the government there. The DNR's been there, offered to help, then brought back fines...that's what they're afraid of. They don't want that." Or Lawton's assessment, a row crop farmer, "It [the lawsuit] might wake up that watershed over there." For many people I spoke with, the projects representing a watershed had become a cultural identifier. Watersheds also carried a sense of moral responsibility in that basing projects off a shared watershed encouraged participatory civic engagement (Cohen 2012).

Yet it was the presence of the watershed project coordinators, and the relationships they built with landowners in their area, that could make (as well as dissolve) a watershed. Often coordinators were new to the area, so they typically became connected with the farmers considered most conservation-minded in the county. These farmers usually had served as SWCD commissioners and were familiar with the NRCS office and their programs. One coordinator told me about an older farmer taking him to the co-op during the morning coffee hour multiple times, and several farmers had walked out as soon as he came in. The relationships the coordinators made early on affected with whom they connected later on in their time as coordinators. Similarly, they inherited some of the social roles and relationships of predecessor watershed coordinators, and this could be quite messy in some cases. Several coordinators told me about their

predecessors running out of money, not keeping up with reporting, and creating difficult relationships with landowners. The size of a coordinator's watershed also affected their ability to learn their watershed. Watershed boundaries were often messy, following the topography, without regard for county lines. This meant sometimes farmers could think they were in a watershed (project) zone, but find out shortly they existed outside the designated acres and the increased availability of funding. Coordinators expressed a range of emotions—pride, frustration, resignation—related specifically to their watersheds.

Acres had histories—the 80-acre farm—that could summon the kind of work done on them. But what did one do in a watershed? What kind of meaning could be extracted from how a part of the landscape “shed” and drained its water to a common source? Watersheds, as scale and place-making, can best be understood through the perspective of watershed project coordinators as well as the agencies in charge of running conservation projects. Coordinators and various agencies have been tasked with spreading conservation—knowledge and practices—throughout their watershed. They became familiar with the boundaries through their labor and access to resources. I went along on water sample collecting trips and did tillage inventory several times with different project coordinators as a way to understand this agro-ecological labor (Figures 3.2 and 3.3). For coordinators, my experience working with Ian can illuminate some of this familiarity with the landscape.

For my first experience, with a Styrofoam cooler between the seats and a clipboard with all the sites on my lap, Ian drove us around the watershed to 40 different sites, such as creeks, tile lines, bioreactors, and saturated buffers. We began at the

“wildest” spot, covered in bluebells and spring beauties, my first encounter with the creek giving the watershed project its name. We went into stream grass buffer strips along streams, fencerows, and fields, sinking into soil or wading through the tall grass. These walks could take 30 to 40 minutes round trip, depending on their location and our mode of transportation. One farmer let us borrow his side-by-side and we drove through restored prairie to a saturated buffer, grass cutting us and seeds flying into our faces. Other sites were right off the side of the road or on a bridge.



Figures 3.2 and 3.3 The labor of water sampling

Getting to tile lines often meant climbing down into quarries, ditches and creeks, hauling our plastic bottles and coffee bucket on a rope to collect samples. Ian had the route memorized at this point, asking me which site number we were on and heading that way. I marveled at this to him, and he said it had taken some time to figure it out. He would predict whether we would find a tile line running or not, based on the weather and other facets of his embodied knowledge. Despite his predictions (and their accuracy), we would walk to dry or submerged tile, in rain, heat, and clouds of insect to check. The process took about four and a half hours, including shipping off the samples immediately to a lab, and was done every two weeks. When an intern and I tried to repeat the process

while Ian was away for training, we spent five hours, had difficulty even finding where some of the sites were located, and ended up sending the samples to the wrong lab. This difficulty showed me that what Ian did was more involved than anyone who had not done it would realize. During one of our trips, several farmers stopped Ian and me to chat as well, adding pleasantly to the long hours of driving, walking, and collecting water. The watershed then was made through Ian's social relationships, ecological experiences, and physical labor. People knew of the project based on his efforts to reach out and the joint efforts between farmer and coordinator to find if their acres qualified for the project's additional funding. Yet they (farmers and other local conservation experts) did not generally know about his material labor for the landscape. This knowledge belonged to Ian. His project shared results from the water monitoring, but Ian was the only one I found interacting with the water of the watershed on a regular basis.

Watershed project funding lasted for three years with opportunities for renewal. I met several project coordinators who had done this work for years; one coordinator had been balancing between multiple grants for a decade. This, however, was unusual. Several of the projects I worked with continue to operate at the time I am writing this, through successful re-applications. During the time I was in Iowa, they were called watershed *demonstration* projects.¹³ The idea behind a demonstration project was that farmers needed to be exposed and allowed to experiment with conservation practices. Some of my research participants expressed frustration that it was not about implementation and instead framed as a learning/experimental experience. Projects like

¹³ Another interesting language choice was that watershed project coordinators were called project coordinators or PCs for short, dropping their association with their watershed.

Ian's did desire baseline information on the water and soil, providing testing services in several formats, but the main goal was to give farmers and landowners enough financial incentive to try different practices that had not been used before.

The politics behind the watershed also became apparent when considering which agencies were responsible for watershed well-being. The most recent iteration of the watershed project was funded primarily through WQI, the state's Water Quality Initiative program, which aimed to fund and demonstrate the practices of the NRS. Most watershed projects were structured like this: the Iowa Department of Agriculture and Land Stewardship (state) funded accepted projects that Soil and Water Conservation Districts (county) designed and the Natural Resources Conservation Service (federal agency with county offices) provided office space and technical support to the project coordinator. Local chapters of the SWCDs were composed of elected, unpaid commissioners, usually five when all seats were full. NRCS increasingly had lost staff, so the District Conservationist, the head of the office, became responsible for two counties. NRCS also shared office space with FSA, the Farm Service Agency, where farmers signed up for crop insurance. Many of the coordinators I met worked for the SWCD and met with their commissioners semi-regularly, had NRCS email addresses, and operated primarily with state funding. Several other WQI projects were run by non-profit organizations, like RC&Ds (Resource Conservation and Development), or farm groups like Practical Farmers of Iowa or the Iowa Soybean Association, which changed the structure. One producer association employee told me with their group's backing, a project coordinator did not have to worry about losing their job after three years, and they could provide benefits and support in-between grants, something other coordinators I spoke with could

not expect. One project coordinator then collapsed multiple scales—state agency, federal agency, SWCD, county, corporate, watershed—into their labor. This demonstrated to me the emergent natures of and fluidity between scales.

Tina, a watershed coordinator for several projects, gave me a historic perspective for watershed projects. Most watershed coordinators used to be environmental specialists working for the IDNR. There had been close to a hundred environmental specialists acting as coordinators, who received good salaries and benefits. With severe budget cuts to IDNR, they were now very few environmental specialist positions. With the SWCDs, a project coordinator was at the mercy of commissioners. One person might get \$10/hr with no benefits versus \$25/hr with benefits. Today watershed project coordinators used the job as a stepping stone and a resume builder. Coordinators overall had shifted to being district employees. There were a few who have lasted many years: 5 to 6 years with decent salary but still no benefits. For people who have worked in watersheds through their whole lives, they knew the funding cycles well. Alice, a SWCD commissioner, echoed Tina,

It's a fight [for project coordinators] since they're grant funded. The state keeps dumping things on us. I had experience dealing with personnel and human resources. I don't know how protective they [the state] would be. Have you seen insurance prices going up? They [project coordinators] only get stipend so when premiums go up... That's the model the state has chosen. District level and grant funded for personnel. [The DNR is being gutted for the] same reason. The state thinks they're saving money. Just stupid.

The IDNR had several issues unique to its agency rather than IDALS. The Secretary of Agriculture is an elected official, while the head of the IDNR is appointed by the governor. The IDNR had a Full Time Equivalency cap when I was in Iowa, which meant the agency could not hire any more staff, hence the hiring of watershed project

coordinators by the SWCDs. These political economic shifts were not always apparent in my conversations, depending on a person's position and knowledge. People expressed frustration with the IDNR and its apparent lack of staff and funding, but did not always seem as aware about the agency's external constraints. There were internal inconsistencies as well. IDNR has been tasked with regulating pollution, but 80% of it is nonpoint source pollution, which cannot be regulated. Another example is that it is illegal for manure to be in streams, but no law against cattle being in them.¹⁴

The consequences of temporary funding and district level watershed conservation projects became apparent in several ways. The people applying for these positions were often young, recent college graduates with environmental degrees (sometimes agronomy), looking for their first job. However, I also met retirees (often from educational backgrounds), farmers doing the work part-time, and people on their second or third career coming to this work. Still, the turnover rate was apparent since roughly a third of the coordinators I interviewed left their positions or had come into their projects part of the way through the project. The state was relying on conservation work—requiring time, rapport, and experiential knowledge—to be done by people with very little economic security. In many ways, it seemed the watershed could in some ways obscure these political economic changes at the state level, as the local was reified as the best scale for enacting conservation. Recalling Alice's comments, watersheds became the purview and, even more, responsibility of counties and SWCDs rather than the state or interstate regional efforts like the Gulf of Mexico Hypoxia Taskforce. Watershed projects competed for funding, often failing if they were outside of the priority HUC8 watersheds,

¹⁴ Several farmers laughed to me at the folly of trying to keep cattle out of waterways.

and the state and federal governments, rather than taking responsibility for the water as a whole, were able to decide which local projects should receive funding.

What did it mean to belong to a watershed? Farms were individually owned with social consequences. On the other hand, watersheds were socially shared with individual actions culminating into consequences. Both were measured in acres. Although the shift to the “local scale” via watershed was meant to encourage local participation in conservation projects, many of these watersheds were at least twice, if not four to ten times, larger than the moral boundary for a farming operation. One person, often young and new to the area, became responsible for the thousands and thousands of football field sized spans of the landscape. This newness also meant coordinators would have easiest access to the “low hanging fruit” farmers first, which some farmers told me was off putting for people who were interested in the project but annoyed with the social superiority of the conservation-minded farmers.

Unlike Sneddon and Fox (2006), who found political focus on waterways disconnected the rivers from surrounding areas and the politics at play there, I found that the watershed masked the waterways. Watersheds made these projects about the land rather than the water.¹⁵ Since many of the consequences for the water stemmed from land usage, this naturalized the focus on land management practices. As I discuss later in this section and throughout this dissertation, a focus on particular aspects and actors in the landscape meant less attention for other aspects of the landscape. My participants would compare different hierarchal ordering for how to implement conservation. Should the

¹⁵ Stream restoration was just starting to be discussed more widely during my time in Iowa. Additionally, oxbows (Figure 3.14) played a small part in conservation practices but not in the NRS.

focus be on soil health or soil loss? Edge of field practices or in-field practices? Nutrients or impairments or something else? Each of these foci had consequences. For a state and conservation projects aiming to address poor water quality but entrenched in Iowa agricultural priorities (i.e. the soil), there seemed to be very little interaction with the water outside of the water monitoring activities of project coordinators. Several participants expressed frustration to me that it seemed the funding for conservation always went to agriculture, which was explained by the ideological and material scale of farming in Iowa. Yet plenty of other places with irrigated agriculture, increasing water scarcity, and decreasing water quality were very attentive to waterways. This seemed to be a peculiarity specific to the ecological conditions of Iowa: corn crazed, and soil and water rich. In the following sections, I describe the materialities of the landscape that contribute to the complexity of scales in Iowa.

3.2 Corn and Soybean Monoculture

The history of prairie has made the contemporary Iowan landscape of corn and soybeans possible. I purposefully introduce prairie as the first vital entity in agriculture, before corn or soybeans, because these histories are entangled and contingent on each other. The loss of prairie on the landscape reverberates in the enormous corn yields of over 200 bushels in the most fertile soils, water pollution, and soil erosion. Prairie made the soil, and the soil is the foundation of corn's success. Prairie and soil are vital entities created through the labor of many (nonhuman) actors—plants, insects, fungi, minerals, microbes—and despite the name, corn monoculture is also composed of many other actors, human, nonhuman, and technologies. However, monoculture indicates hierarchy, where, despite all the actors involved in monoculture, the success of corn and soybeans as the focal companion species encompass the goal of different labors and tensions between

factions of actors. This hierarchy diverges drastically from the necessity of multiple human and nonhuman actors to succeed through co-existence, through tension and struggle, within the vital entities of the soil, prairie, and as I will discuss, water.

Joe, a hydrologist, highlighted the history of the agricultural landscape in this way to me. Before WWII, the land was a quarter corn. Alfalfa, small grains, and manure from livestock were integral parts of the agricultural system. In the 1950s, soybeans became another cash crop. This, he indicated, was where the problems began. Soybeans replaced oats and alfalfa because a cash crop was more appealing than the small grains. By 1970, the oats and alfalfa were gone, and without these root systems, nitrates increased in the stream. Soybeans were just as “leaky” as corn in terms of nutrient loss, although their ability to “fix” atmospheric nitrogen rather than use fertilizer was discussed as a benefit. It was a problem of the cropping system, Joe said, not fertilizer. Joe’s account implicitly included the introduction of the tractor and mechanization, which replaced draft animals needing the small grains. These kinds of technological innovations have allowed farmers to continue farming into their 70s and even 80s. His account also demonstrated to me that knowledge about farming was not the sole realm of farmers. Much of the expertise lay elsewhere, with crop consultants and input dealers, for instance. But even in the natural resource conservation, like for Joe’s work in hydrology, he required fluency in agricultural history, for legitimacy in these the intersections of farming and conservation, and the background for his work.

Today corn rules Iowa, in and out of the fields. The teosinte-maize-human progeny is embedded in the aesthetic of Iowa, in the state capitol architecture, postcards

and key chains at gas stations, salt and pepper shakers on kitchen tables (Figures 3.4 and 3.5).



Figures 3.4 and 3.5 Iowa aesthetic. Top photo is sand sculpture at Iowa state fair in 2016. Bottom photo is a bench in Iowa City, IA.

Dean—a grain and dairy farmer—put corn’s success to me in this way: you cannot beat a crop where one seed will reproduce itself one hundred times over, between 150 and 300. Echoing this sentiment, Richard, a farmer with a deep love for Iowa and soil health, said, “Corn is what we really care about, what we really get excited over.” His fascination with cover crops and lively soil was inseparable with his excitement over corn (Table 3.1).

Table 3.1 Corn and Soybean Data in Iowa in 2015 and 2016

Crop (Year)	Acres Planted	Acres Harvested	Average Yield per Acre for Iowa (bushels¹⁶)	Total Yield for Iowa (bushels)
Corn (2015)	13,500,000	13,050,000	192	2,505,600,000
Corn (2016)	13,900,000	13,500,000	203	2,740,500,000
Soybean (2015)	9,850,000	9,800,000	56.5	553,700,000
Soybean (2016)	9,500,000	9,450,000	60.5	571,725,000

Corn's success has to do in part with its nature as a plant, illustrated compellingly by Pollan (2006). Corn is versatile—it can capture more carbon for its growth during photosynthesis and make more with same amount of resources as other plants (2006: 21-22). Corn is ubiquitous in the industrial food system in terms of production and consumption. Corn supports multibillion-dollar corporations that provide the seeds, chemical inputs, and mechanical equipment to grow and process corn. Corn is also in everything—it is fuel (ethanol), meat (livestock feed), and food (sweetener, additive, and grain). Echoing Pollan (2006) and Stark (2015), corn features in a trip to the grocery store in plastic packaging, wax on produce, materials for the building, in addition to being a food product. I was told that labor unions (e.g. The Bakery, Confectionary, Tobacco Workers, and Grain Millers Union) were invested in the corn industrial system. This demonstrates the multiple industries and social groups that rely on the production of cheaply available corn as a component of commodity production, as well as the research that found these industrial uses for corn. The federal government—through taxpayer dollars—has subsidized corn around \$106 billion between 1995 and 2016, with Iowa

¹⁶ A bushel of shelled (no cob) corn is 56 pounds.

receiving the most subsidies at over \$18 billion during that time period (Environmental Working Group 2018a). During my time in Iowa, farmers raising corn throughout the country received \$12 million, mainly through crop insurance and agricultural risk coverage. The subsidy program was meant to provide farmers with a safety net during economic downturns and extreme weather conditions, but tends to support five main commodities, including corn, and the largest farming operations (Environmental Working Group 2018b). While cornstalks dominate the landscape, comparatively short and bushy soybeans are a consistent part of alternations in most parts of the state. Still, they are second in the hierarchy because soybeans can never be as prolific as corn, averaging around 60 bushels on good soil.

I witnessed the care for corn in action on one of my visits to Richard's farm. We went out to a field they were planting, where he explained the stress that farmers often felt around this time, a genuine "Iowa nice" moment. Richard wanted to show me the process and let me into a cultural insight concerning the highly emotional state of planting season (Figures 3.6, 3.7, 3.8, and 3.9). At one point, I stood in the field with him as the tractor made slight furrows in which the seeds were planted. Richard got on his knees and hands, checking the furrow depth and width with a tape measurer he drew out of his pocket. He had showed me the corn kernels, blue with a seed coating that he said "contained two known carcinogens," mixing the seeds with his bare hand, ignoring my quiet reproach, "Richard!" This trip showed me the multiple kinds of labor that can go into planting season—physical, mechanical, emotional, and mental all expressed by Richard in a matter of hours.



Figures 3.6, 3.7, 3.8, and 3.9 Richard's farm. Top left, corn covered in seed coat powder. Top right, Part of corn planter. Bottom left, Richard measuring depth of corn planting. Bottom right, Corn planting in action.

Mariah, a young woman working on a large-scale farming operation, described the development of hybrid seeds (see Ziegerhorn 2000 for hybrid corn development). A farmer planted, raised, and harvested commercial corn. A 50-pound bag of commercial corn seed is usually between 300 and 400 dollars, the price for GM traits, which covers roughly two acres. Seed corn was an inbred cross that you used to breed the hybrid. With seed corn, there were both emergence and pollination issues. Seed corn must be de-tasseled, which has been mechanized, where in the past, farmers had kids or migrant workers manually pull out the tassels from the female. Seed corn growers must be very careful about in-blown pollen for seed quality because corn pollen is fine like dust and travels easily in a windy place like Iowa. Seed corn has lower yields, and it requires higher management. Mariah had worked in pre-foundation seed corn production, which meant going from 40 kernels in the palm of your hand to 80,000. Seed corn may get

grown out in Hawaii, which has a longer grower season. Going from that 40 kernels to 80,000 can take a year and a half, when the farmer will then be able to grow the hybrid's seed corn. Hybrid corn was a trade-off between farmers developing their own seeds and the promises of biotechnology for yield improvement and crop vigor. The process of developing hybrid seeds showed me the distance between farmers and the corn they grew and cherished.

Farmers await multiple hybrids and gene traits, vying to try the latest varieties, which often have a limited availability. Social relationships can be crucial in accessing insider knowledge as well as opening avenues to secure the seed. As I drove to and through Iowa, I noticed the hybrid signs flashing by. They were a different kind of road marker on the edge of fields of rows of tall green stalks branded with Monsanto, Syngenta, Pioneer, then a series of numbers and letters. Could farmers decode what is only branding to me? How did companies feel if their signs were next to pathetic fields, stocky corn sporting pale green leaves in the middle of July? These signs were one of many signals that this was a commodity landscape (Figure 3.10).



Figure 3.10 Commodity landscape. An evolution of corn, seen in a wing at the state capitol

Most corn and soybeans were destined for the world market, and both farm groups and farmers sought ways to increase profitability. The main strategy for farmers was to grow as much corn as possible and to sell when prices were highest. Some farmers also told me about careful consideration of inputs, and that high yields were not useful if the expense of planting, growing, and harvesting crops exceeded what their impressive yields could garner. Yield was a source of pride, though, and farmers enjoyed boasting about their numbers to me. Other strategies included finding new or niche markets. New markets could be found at the federal and transnational levels, with farmers lobbying for advantageous trade deals (e.g. the Trans-Pacific Partnership during my fieldwork), as well as an interpersonal level, where farmers would meet visit other countries and work with interested buyers, both governmental and corporate. At the Farm Bureau convention, I attended several talks where farmers reported on trips to different parts of the world, like Brazil, Japan, and China. These reports felt akin to reconnaissance missions to me, where farmers assessed the country as competition or consumers.

The relationship between a farmer and their corn did not result in walking out in the field, checking each plant's success. Corn's abundance allowed for individual losses. The rows were planted so tightly that walking between fully grown corn would require unnatural acrobatics. I did stand in several cornfields, my body knocking plants slightly or my feet precariously close to the stalks. Soybeans offered more room to walk, and I spent several interviews waist deep in a bean field, turning leaves over to reveal fuzzy pods and jeweled beetles making holes in the leaves (Figure 3.11).



Figure 3.11 Soybean plants flowering, fruiting, eaten

In the past, many young people found summer jobs walking beans, getting rid of loathsome weeds, before the time of Roundup. Farmers would seek the success of a population, not individual plants. Individual corn and bean plants might succumb to wildlife, a rogue highboy wheel spreading pesticide or cover crop seed, or a clumsy ethnographer. Disease, insect pressure, and difficult weather threatened farmers more than these small-scale disturbances. Crop scouts, and more recently, drones, scanned the fields for possible problems sensed through visual assessment.

In a monoculture, one species receives primary attention. However, farmers and those aiding them must consider other entanglements, and their attention must stretch to include anything interacting and affecting this focal species. Monoculture is facing increasing weed resistance, and aggressive, successful plant species like palmer amaranth incite anger and fear across farming worlds. Pesticides cannot keep up so farmers were resorting to more aggressive combinations of chemicals or tillage, both of which set off a cascade of other issues. Disease too can devastate cornfields, and insects can destroy

plants' ability to grow, damaging their leaves or roots, essential sites for nutrient production and distribution. During a combine ride at harvest time, my eyes followed the mice and rabbits racing away from the enormous machine, and watched in amazement as a young stag stared us down while two doe consorts fled from the destruction of their temporary hideaway home. The farmer said you could see foxes and even coyotes prowling the edge of fields during harvest season, awaiting the combines' chaos, sending prey out into bare neighboring fields. Beavers stole corn stalks to add to their dams in creeks running alongside fields. Farmers would plant food plots to attract deer and pheasants for hunting as well. These invasive plants, insect pests, and mammals using fields as habitat are all subject to surveillance through the mechanical, chemical, and social means. Their interconnections demonstrate that monoculture may mean one species dominates, but it is hardly alone.

The true star of cornfields is the soil, a product of the prairie and foundation for agricultural thriving. In the context of monoculture, soil exhibits a wide range of liveliness and death. Soil can host insects like earthworms and nightcrawlers; microbes; the delicate netting of mycorrhizae fungi; plant roots and seeds; tiny mammals burrowing. Tillage, the act of turning the soil mechanically, damages and even destroys this ecosystem. Farmers using tillage typically described the need to heat the soil up because corn seeds like heat, and heavy tillage increased in the areas of Iowa with cold, heavy, dark soil (e.g. the Des Moines lobe in north central and western Iowa). Other farmers with more delicate soil, such as HEL (Highly Erodible Land), would utilize no till part- or full-time, only disturbing the soil to set seeds in a furrow. More typically, farmers used some kind of tillage, what they called minimum or conservation tillage,

going into corn planting. The soil responds in different ways depending on how often machinery cuts through it. Its texture can crumble like baked cake or like flour; it can be dry or cool and damp; it may have holes and roots in it or it may look deserted. The healthiest soil, I was told, looked like baked cake, was cool and damp, and full of activity.

Many farmers and non-farmers alike speak of Iowan soil with a sense of reverence that resonates with familial, human, and geologic temporalities. After a very short period in Iowa, I knew a state aphorism: “Iowa soil, only 10,000 years old, is some of the best soil in the world.” Its youthfulness and long-standing relationship with prairie made Iowan soils unique. Only a few places like Croatia has soil akin to Iowa, and Croatia does not have the climate of Iowa supporting agriculture, several people told me. A glacier slid through Iowa 10,000 years ago, creating the Des Moines lobe, and prairie came in its wake—an ecosystem with deep and diverse root systems. Iowa soil supports Iowa’s corn habit, a needy crop when it comes to nutrients. Science—particularly with hybridization and fertilizer—has teamed up to co-produce some of the best corn yields in the world in Iowa. However, the fact that Iowa soil is almost too good, too fertile and rich, creates a different conundrum in contrast to naturally poor soil fertility, and when it comes to soil health (see Chapter 6).

3.3 Too Blessed: Rain, Rivers, and Tile

The Missouri and Mississippi River line the western and eastern boundaries of Iowa, and within these boundaries are thousands of miles of rivers, streams, and creeks, and acres of lakes (Figure 3.12). Rain falls abundantly, on average around 34 inches annually (NOAA). Pre-colonial Iowa was home to wetlands and prairie, which allowed for immense water holding capacity. When colonists began plowing the prairie in order to

farm, often they faced very wet, very fertile soils. Iowa is a landscape where farmers want water gone, a disjointed desire in a time of water scarcity discourse and policy (Barnes 2013).



Figure 3.12 The North Raccoon River in Sac County, IA

For further context, I studied Iowa's water during the beginning of horrific revelations over Flint Michigan's lead contamination in drinking water and in the midst of the protests against the North Dakota Access Pipeline at Standing Rock, as well as in Iowa. The debates over water quality then resonated on multiple scales. The local river entwined in the most intense politics was the North Raccoon River, as this was the river at the center of the DMWW lawsuit.

I cannot tell the story of Iowa's water without that telling including drainage tile. As one conservation expert told me, "Tile is our sacred cow. We don't want to touch it." The goal of tile is to move water out of an area by providing a larger path for water that otherwise would trickle down through the soil profile or slowly make its way out to rivers and creeks. The tile discharges into whatever waterway is available, drainage ditches, rivers, creeks and streams. The temporal and spatial scales of tile are mysterious since no

legal parameters have required notification about how much or where tile went into the landscape, and installation of drainage tile is considered a private business decision rather than a broader landscape alteration. Dean told me with admiration that European colonists put in the first tile by hand, clay pipes with gaps in between, laid into trenches made by 66 feet of chain dragged by horses. The wondrous thing, he said, is that this tile was mostly straight. The tile of today consists of tubes of ridged black plastic with perforations to let in water, put into the ground with machines, often after the harvest (Figure 3.13). Most tile is six to eight inches in diameter, although it can go up to two to three feet, which can exceed the capacity of conservation practices like bioreactors and saturated buffers, edge of field practices that filter water through wood chips or diverted tile along river banks, respectively.

Dean relayed a conversation he had with a neighbor about the history of tile. Before WWII, tiling was all done by hand and with clay. Most communities had clay factories where the natural clay was dug from the ground and made into tile and blocks, much like pottery. It was replaced by cement in the 1950s, and by plastic in the 1970s. Both clay and concrete tiles were a foot long and came in different widths. They were all laid end to end with the crack between allowing soil moisture to enter. Tile relies on gravity, meaning there has to be a difference in elevation for the tile to move water. A tile line is supposed to remove water from ten feet on either side, for each foot it's buried. So a line installed at four feet should drain an area forty feet each way, or eighty feet wide. Most were buried deep enough to stay below the average frost depth, which in many areas of Iowa is considered to be about four feet. In the past, tile was laid in "wet spots" that made it difficult to farm, but a recent strategy called pattern tiling has become more common,

where at regular intervals, tile is put in throughout a field.



Figure 3.13 Drainage tile on a farm

A DNR representative shared at a water monitoring training that miles of tile outnumbered the numbers of roads ten to twenty times over, with tile covering an estimated one to three million acres. She then compared the hydrologic cycles of prairie, agricultural fields, and urban spaces. Prairie had a very slow hydrologic cycle, allowing only 5 to 10% of rainwater to escape into streams and rivers. In contrast, an urban system allowed 80 to 85% of the rainwater gets into the stream. For farmland, it was about 40 to 60%, reaching its peak in March. When rain splashed on soil, it created a sheet of soil that the rain just ran right off. So in the winter, farmland acted more like urban spaces because the soil was bare, while in the summer, it acted more like prairie. Cover crops could help mimic the old prairie, she concluded.

Joe the hydrologist characterized tile (in addition to soybeans) as the villain. Without tile, there were lower yields, or a farmer simply could not use the land. If they were farming five thousand acres, without tile, it became very risky. Places like the Des Moines lobe have cold soil; the topsoil is deep and freezes deep down. Tile helped the soil warm faster and increased the length of the growing season, essential for corn.

Pattern tiling had helped increase yields, and banks would provide loans when farmers showed through their yield monitors the increases in yield they gained over tiled land. Tiling was the new tillage; it had the same effect on organic matter. Prairie streams had very low nitrates, but tile increased the delivery of nitrates to the stream, and without growing vegetation, the nitrates were vulnerable to loss. This did not absolve farmers, he repeated. They created this system. Tile, nitrates, and water were interlocking and interrelated.

In a typically rain rich area like Iowa, water logged fields drowned out seeds or completely prevented planting. Tile is entangled in a history of moving water quickly away in order to farm, to make livelihoods. However, tile is not the only transformation of Iowa's waterways. Streams used to meander, curving back and forth in time and space with the landscape. These streams were channelized and often armored with cement to transform waterways into drainage ditches, creating straight lines that echo the regular rectangles and lines of county lines and roads. Without meanders, the water moves at a speed and volume that creates muddy and chaotic environments, where many species cannot thrive. Aquatic plants, mussels, algae, and beavers all had historic roles in nutrient reduction and they all needed slower water to catch their food and build their homes. The very physical structure of creeks and rivers helped with nutrient reduction, creating conditions of slow lively water that could use and convert nitrate and nitrogen. Streams have lost their biological processing because of human technologies like channelization and artificial drainage systems. To slow water down, some conservation experts advocated for restored wetlands and restored meanders called oxbows (Figure 3.14).

These ecologies aided in recreating slowness, which encouraged biodiversity and nutrient processing.

Tile connects crops, nitrates, running water, and the absence of multiple species—broadly, the lively waterway—into a complicated relationship. It becomes a source of uncertainty and insecurity, reflected in questions posed to me by multiple research participants. Were the nutrients coming from tile really making it from these northern counties to Des Moines? Could tile be regulated since it generally passes through multiple fields, transcending boundaries of individual ownership? What could a farmer do if the numbers coming out of his tile line were high?



Figure 3.14 Oxbow restoration project in Wright Co, IA (Red arrow indicating oxbow)

In general, farmers favor tile because it makes land (more) productive. Tile is the single best investment a farmer can make, one no-till and cover-cropping farmer told me. Another farmer lamented, what does Bill Stowe want us to do? Tear out tile and lose productive acres? Former Governor Branstad echoed these fears at a conference dinner, stating “that the EPA could require them to take the tile out and we would lose some of the most productive soil in the world to swamp.” For farming desires, tile was seen as

essential. However, tile had its limits here, too, in the agricultural world. An example given by a farmer participant, Peter, illustrates this point. Peter came home from work one day, and his neighbor—a large-scale progressive farmer—was pattern tiling his whole field. Eighty acres of that neighbor’s field drained into Peter’s field. Peter had two six-foot tile lines at each end of his grass waterway, which he knew wasn’t going to handle this new flow of water. Peter asked his neighbor, what was going on? Did they think to tell Peter they were going to do this?

The NRCS staff told Peter there was no obligation to discuss tiling decisions with neighbors, despite sharing a field border. That year Peter had a really muddy, really wet waterway all year, and he had to put in new tile. After telling me this story with frustration, Peter concluded pattern tiling was the biggest issue facing water quality. ISU research may state it pays for itself, but Peter asked, at what cost? Pattern-tiled land faced problems with retaining soil moisture. While few farmers told stories like Peter’s, his experience showed me the politics of tile that could emerge within farming. Tile may be on private land, but its transportation of water exceeds field boundaries, affecting other people’s private land as well as public waterways.

For people not using tile, i.e. non-farmers, their responses were more ambivalent. Tile created problems in equal proportions to improving yields. Tile dried out wetlands. It encouraged farming of acres that, under other circumstances, were not very productive. It sent unfiltered water straight into creeks and river, adding to the flashiness contributing to flooding. Tile did not come up very often in conversations about conservation, however, unless discussing the idea of a saturated buffer or bioreactor. Tile seemed to be taken as a fact of the landscape, and other solutions would have to address tile’s inevitability. One

exception was Starla, who explicitly grappled with the problem of tile during our interview. Often, conservation experts turned to cover crops and reducing tillage. Sometimes they discussed edge of field practices. Starla, on the other hand, went to what she framed as the root cause of water quality problems.

Personally I think we should get rid of any tile that goes directly into a waterway. Any, any at all. If they want it [water] off their land, fine. But it needs to be filtered. Saturated buffers—that I think could work. They could put in wetlands. They could stop them [tile] before the river. It's not different than seeing a pipe coming out of a plant [factory]. It's not different to me. That would be huge in stopping the issues with nutrients in the water. That would be my number one thing.

Starla had instructed to read me a study done in Indiana where researchers broke tile lines on the edge of fields and filled small trenches with water-loving plants (The Nature Conservancy). These trenches created a miniature wetlands effect. This idea fascinated me because it was so different than other conservation practices. I wondered if, because tile was so vital and inevitable to farming, people generally looked past it. This kind of looking past would also occur, in a more complex way, in regards to cover crops. Cover crops, also deemed vital for the landscape, had certain fundamental problems in their application, specifically due to be a part of a corn agriculture system.

3.4 The Silver Bullet: Cover Crops

In Iowa, no practice received more attention during my fieldwork than cover crops. It was featured in most field days, and everyone had a position on cover crops, whether positive or negative. An excerpt from an Iowa State Extension document collected from a field day (Figure 3.15) shows the Strategy detailed more than cover crops, but acres of cover crops became a measure of success in ways that other practices were not. As one participant told me, farmers like to grow things, and there is no better advertisement than a green field when the rest are brown and empty.

Iowa Strategy to Reduce Nutrient Loss: Nitrogen Practices

This table lists practices with the largest potential impact on nitrate-N concentration reduction (except where noted). Corn yield impacts associated with each practice also are shown as some practices may be detrimental to corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

top 5 fall

	Practice	Comments	% Nitrate-N Reduction ⁺	% Corn Yield Change ⁺⁺
			Average (SD*)	Average (SD*)
<i>ammonia stable form</i>	Timing	Moving from fall to spring pre-plant application	6 (25)	4 (16)
		Spring pre-plant/sidedress 40-60 split Compared to fall-applied	5 (28)	10 (7)
		Sidedress – Compared to pre-plant application	7 (37)	0 (3)
		Sidedress – Soil test based compared to pre-plant	4 (20)	13 (22)**
	Source	Liquid swine manure compared to spring-applied fertilizer	4 (11)	0 (13)
		Poultry manure compared to spring-applied fertilizer	-3 (20)	-2 (14)
	Nitrogen Application Rate	Nitrogen rate at the MRTN (0.10 N:corn price ratio) compared to current estimated application rate. (ISU Corn Nitrogen Rate Calculator – http://extension.agron.iastate.edu/soilfertility/nrate.aspx can be used to estimate MRTN but this would change Nitrate-N concentration reduction)	10	-1
	Nitrification Inhibitor	Nitrapyrin in fall – Compared to fall-applied without Nitrapyrin	9 (19)	6 (22)
	Cover Crops	Rye	31 (29)	-6 (7)
		Oat	28 (2)	-5 (1)
	Living Mulches	e.g. Kura clover – Nitrate-N reduction from one site	41 (16)	-9 (32)
<i>abundant nitrification</i>	Perennial	Energy Crops – Compared to spring-applied fertilizer	72 (23)	
		Land Retirement (CRP) – Compared to spring-applied fertilizer	85 (9)	
	Extended Rotations	At least 2 years of alfalfa in a 4 or 5 year rotation	42 (12)	7 (7)
	Grazed Pastures	No pertinent information from Iowa – assume similar to CRP	85	
<i>abundant nitrification</i>	Drainage Water Mgmt.	No impact on concentration	33 (32)	
	Shallow Drainage	No impact on concentration	32 (15)	
	Wetlands	Targeted water quality	52	
	Bioreactors		43 (21)	
	Buffers	Only for water that interacts with the active zone below the buffer. This would only be a fraction of all water that makes it to a stream.	91 (20)	
	Saturated Buffers	Divert fraction of tile drainage into riparian buffer to remove Nitrate-N by denitrification.	50 (13)	

* A positive number is nitrate concentration or load reduction and a negative number is an increase.

** A positive corn yield change is increased yield and a negative number is decreased yield. Practices are not expected to affect soybean yield.

* SD = standard deviation. Large SD relative to the average indicates highly variable results.

** This increase in crop yield should be viewed with caution as the sidedress treatment from one of the main studies had 95 lb-N/acre for the pre-plant treatment but 110 lb-N/acre to 200 lb-N/acre for the sidedress with soil test treatment so the corn yield impact may be due to nitrogen application rate differences.

Figure 3.15 Nitrogen reduction practices of the NRS

Cover crops are plants that provide cover for the soil between harvest and planting seasons. Typically, cover crops are seeded into an active corn or soybean field, by airplane or Hagey highboy (Figure 3.16), or immediately after a harvest, sometimes as the harvest is in progress. The most typical cover crop during my fieldwork was cereal rye planted before a soybean crop, which during a good season and with a thorough seeding, turned agricultural fields into vibrant lawns, a stark contrast with the bare ground of neighboring fields. Oats, annual rye, hairy vetch, clover, tillage turnips and radishes and multispecies mixes were other cover crop candidates, but with fewer farmer and researcher proponents.

Cover crops are somewhat like an unfinished commodity (Paxson 2013). Their role on the landscape was unclear and yet to be determined. Would they exceed management, not growing or not dying? Would the weather complicate their lives? Socially, cover crops generated a lot of excitement, but also exasperation and exhaustion. While some of my participants were firm advocates of cover crops, saying every field must have them, most people felt more ambivalent and frustrated when cover crops were treated as a “silver bullet.” Although cover crops had been used off and on for a long time, it had not been within the recent tenets of soil health (see Chapter 6).

From an ecological position, cover crops provide the active roots that can keep nitrates put, that result from microbial work and fertilizer in the field. They can increase organic matter, the substance that makes living soil rather than dead dirt. People hoped for weed suppression and possible livestock fodder. Cover crops are supposed to collaborate with microbes, water, and soil to provide a multitude of environmental and agro-economic benefits. They also could reduce phosphorous loss, holding the soil and

thus phosphorous in place to prevent erosion. However, they also presented a multitude of issues at every step of their implementation.



Figure 3.16 Hagey highboy converted to spread cover crop seeds

Depending on the seeding strategy, cover crops might grow voraciously or barely at all. When delivered to the soil by airplane, the spread could be uneven, and rain had to come quickly to awaken the seeds to root. If the touch of rain or soil was not just right, a field would be patchy or bare. Hagey highboys—tall pieces of equipment typically spreading fertilizer or pesticides—could be adjusted to spread cover crop seeds, but the timing to move the Hagey through tightly planted corn proved a difficult endeavor (Figures 3.17, 3.18, 3.19, and 3.20). A cover crop seeded directly behind a combine with an attachment to the combine or through another piece of equipment had the best chance for success; it could be delivered directly into the soil without competing with cash crops for water, light, or nutrients. The weather would determine whether harvest time could allow for an additional activity like planting cover crops.

In the spring, if the cover crop overwintered and began to grow again, farmers killed it with herbicide in advance of their next cash crop, particularly corn. The most

popular cover crop, cereal rye, and corn are both warm weather grasses, and rye could impede the growth of corn as they both compete for resources if their growing times overlapped. As I mentioned before, the yield of corn is a source of pride and livelihood, so rye received skepticism for this aspect as well.



Figures 3.17, 3.18, 3.19, and 3.20 Cover crops. Top photos left and right, rye and multispecies mix including turnips and tillage radishes. Bottom photo left, terminated rye in spring, being planted to prairie. Bottom right photo, cover cropped soil at a field day.

Due to their precarity next to cash crops, cover crops were often killed before they could do the work the NRS described: nitrate reduction in waterways. The ground would still be bare at the critical point of warmth and wetness. Microbes responded enthusiastically to this weather while the cover crop died and the corn had barely begun to grow. Or the cover crop had died in the winter, leaving the ground bare all spring. If the cover crop held nitrogen and nitrates in the soil during its growth, my research participants wondered whether it could exacerbate the problem, tying more nitrogen—with their own lives and deaths—into the soil that would then be released into waterways.

Typically, cover crops were linked to cattle operations; seed corn, which is harvested earlier in the fall; and warmer climates and soil types, in contrast with the heavy, dark, wet soil of the Des Moines lobe. Cover crops' position in Iowa had more precarity in general because increases in organic matter were very modest within an already rich, fertile context, compared to soils with low natural fertility and organic matter.

Within farming, the limitations of cover crops were obvious. They required changes in land management, a difficult "ask" since it required holding space for uncertainty and risk, significant behavioral changes, and ideological shifts. Some of my participants would dream of ways to make cover crops work on the Iowa landscape. Perhaps a seed coating that encouraged growth at specific times, a project worthy of Monsanto, one told me. Cover crops were difficult to tie to quantitative economic benefits, and for that reason, many farmers in the corn assemblage used them with curious misgivings or not at all, preferring to watch neighboring fields for signs of success or failure.

For conservation groups and actors, cover crops fit well within their desires for soil and water preservation and renewal, although the plants' quick, planned deaths created concern. Planting cover crops brought up issues with crop insurance until recently, and for program participation, farmers had to obey specific NRCS guidelines in planting to receive cost-share, which many of them did not want to do. Within operations using cover crops religiously, farmers could feel a difference in their soil. The change was not quantitative but qualitative, they often explained. It assaulted the senses, this change, bringing new smells, textures, and feel. The soil felt more buoyant than jarring on their joints. It was living. One farmer took me out to a field, a shovel in hand, and

together, kneeling into buoyant soil, we crumbled the architecture of lacey roots, insect tunnels, and minerals between our fingers. The coolness on my palms, the smooth crumble of the soil after the tension giving way to my fingers' pressure, the hidden structures inside, along with the farmer's enthusiasm inspired wonder in me, too. I had walked on and felt dry, hard soil, and suddenly words like *tilth* and *mellow soil* made sense to me. One evening, the farmer recalled, a field of cover crops had come alive with earthworms and insects after a rain, a biblical event, demonstrating to him that these fields had become reliable homes again, with his combined practices of no till and lively cover crop roots.

Some farmers were curious and experimental in their approach to cover crops. I met several farmers who were trying crimping or rolling their cover crops (Figure 3.21). I watched with a rapt audience, varying in levels of skepticism, as a tractor pulling a roller drove around a field of rye grass so tall people waded into it like water, arms up, pushing through waves. If this rolling worked, the rye would die without the need for pesticide and provide ground cover as the soybeans being planted grew.



Figure 3.21 Rolling rye for soybean planting and drone surveying.

Other arguments in favor of cover crops included that farmers liked to make things grow. Growth was a source of primary joy. Some saw cover crops as their way to prove compliance in the face of regulation, or they would be “ahead of the game” when cover crops became mandatory. With committed, regular practice, cover crops could pull the agriculture and conservation together. Soil health, a tenet of cover crop practice, had a draw that echoed of the prairie, and perennial crops.

3.5 Scale: Materialities

I have already touched on three realms of vital materialities: corn and soybeans, drainage tile and waterways, and cover crops. Through my discussion of acres and watershed, I discussed the material practices that make farming operations and watershed projects. In this section, I discuss something else. It would seem that corn and soybean monoculture limits diversity while conservation practices encourage it. To demonstrate variation, I will examine moments when corn agriculture sought diversity and conservation became constricted by the particulars of focusing in on nutrients.

3.5a Corn varieties and livestock as conservation contexts

Yellow dent corn—called such because of the characteristic indentation as the corn dries—constitutes the majority of the corn grown in Iowa. It is turned into ethanol, livestock feed, and grain byproducts. About 39% of Iowa corn becomes ethanol, and in the 2014 through 2015 season, 21% fed livestock (Iowa Corn Growers Association). It was estimated that while an Iowa cornfield could feed roughly 14 people an acre, in 2013 it only fed 3 people, mainly through animal products (Foley 2013). For a while I asked what row crop farmers grew. Eventually I stopped because they would rarely differentiate in corn varieties unless it was seed corn. Soybeans were much the same as corn in that special varieties were not grown. There were two major exceptions: non-GMO soybeans

and soybeans grown for a program like Unilever's Sustainable Soy. However, farmers interested in diversification would tell me about the different varieties of corn they were trying. In areas close to Cedar Rapids, several farmers told me about growing white and waxy corn varieties, which they would take to Quaker Oats. "I actually do grow food," one farmer growing white corn told me with mild amusement and consternation. Waxy corn, a father and son farming operation said, has different starch content than regular corn, which allows us to "get away from petrol," is used as a thickener, or "that gloss on photo paper? That's from waxy corn."

At a plant breeding field day in September 2015, I sat with a room full of people in a large shed, decorated with antique farm implements and dried corn cobs. One of my neighbors at the field day was an organic fertilizer dealer and a cattle farmer who used cover crops regularly. My other neighbor was interested in niche markets, like non-GMOs (Figures 3.22, 3.23, and 3.24). Several main themes came out at this field day. The majority of corn grown in Iowa today was about high yields. People here wanted to think about corn in different ways, especially nutritional content. Lysine is the only missing amino acid in corn, and new varieties with lysine added were meant provide a whole protein in corn. Dean, a dairy cattle farmer, said some varieties are like gravel, and it was mysterious to him how that produced anything. Lysine corn was very sweet and had a lot of wildlife pressure, but it had been good for his cows. There were starch resistant varieties, good for not spiking diabetes conditions; soft kernel varieties for improved digestibility; and high carotene corn that could help with vitamin A deficiency (a variety targeted at India in the past, but not without complications). These varieties

generally had lower yields than conventional corn, but could fit into niche markets for higher prices, if the market could be found.



Figures 3.22, 3.23, and 3.24 Specialty variety corn. Left: Corn on display. Right top: In the test plot. Bottom right: A corn meal made of high lysine buns, pork fed on high lysine corn, (blue corn) tortilla chips, lysine cookies, blue corn muffins, caramel mushroom popcorn.

On a tractor ride with about twenty farmers, one of our stops was at the machine shed of a farmer raising 1,700 acres of organic corn, soybeans, and small grains. The organic farmer explained their conversion to organic in these terms: They tried some of it out with corn prices were \$1.20, and you could get \$3.25 for organic. It just was something they thought they'd try. He slowly converted over ten years, and he wonders if being faster would have been more profit since the market grew so quickly. In an economic downturn, people didn't buy high-priced organic food as much. He summarized it as a way to compete for really good market prices. I wondered how he would have framed growing organically to just me, or a group of urban people, or "foodies." For the crowd of mainly conventional row-crop farmers, he intrigued them with the comparison to conventional growing and the motivation to go organic,

specifically the prices surpassing conventional corn and beans, even with the lower yields.

Unconventional corn and beans were rare topics and practices during my fieldwork. Still, they demonstrated a desire for diversification, ecologically and economically, that pushed against the idea of corn and soybean monoculture as only a simplifying and specialization process. It also created a scale that was both nationally and locally connected, where the organic farmer's products mainly went to Oregon organic dairies while his smaller acreage required intensive management and care, and more human labor.

Another aspect of materiality, labor, and scale in the agriculture was livestock. This was not a major aspect of my fieldwork, although hog confinements in particular were scrutinized for their impact on water quality (e.g. Durrenberger and Thu 1996; Thu and Durrenberger 1998). A few farmers discussed their concerns about the impact on water quality of these confinements, in terms of manure holding cells, manure application, and the amount of water required to support the buildings. However, this was uncommon. One Iowan friend often would ask me how I could not discuss hogs if I was studying water quality? Sorry, Katharine, I would think, I just can't do it. However, what follows is my part of my reply. On my first meeting with a farmer orchestrated through my own efforts, I rode in a combine with him, feeling seasick on the hilly climbs after about an hour. He told me I could take photos as long as "I wasn't one of those radical animal activists." This is when I learned about the "ag gag" laws, arising out of visual documentation done by animal activists on the conditions inside animal confinements. In 2012, this law criminalized any undercover reporting on working conditions, health

hazards, and animal welfare within meatpacking plants, animal confinement, and other agricultural facilities. This issue had created a deep mistrust of outsiders for many farmers whenever livestock agriculture came into conversation.

His mistrust of potential animal activists was further validated as I sat in my car after the combine ride, trying to recover from motion sickness, and another farmer came speeding up to me in his truck, jumped out, and angrily loomed over me. He demanded to know what I was doing there, who I was, and why I was next to his hogs. I looked over, registering the long building, slits of windows rolled open, and animal noises emanating from within. I was able to calm him by mentioning the farmer driving me in his combine, but his initial ferocity stuck with me. My fieldwork was already investigating a sensitive issue that had people on edge, and I was already suspect to many of the people I worked with. Additionally, I did not know if I could bear it. I saw inside one sow breeding facility, and listened as impassively as possible to the farmer tell me about how this was more humane and biosecure. Caleb, a young corn and bean farmer who did not have livestock, told me,

Quality of life for hog is better in confinement. They get sunburnt [outdoors]. [In a confinement it's] 70 degrees, [they have] access to food and water, it's climate controlled, it's clean. It streamlines, you vaccinate if need be. A lot easier than the old way. Innovation is looked upon as a negative.

This was a typical position in the agriculture. By not directly studying hog confinements or livestock in general, farmers revealed to me aspects of keeping livestock that otherwise I may not have seen. In the agriculture world, hog confinements did not come up much in terms of nutrient reduction or water pollution. However, multiple farmers told me that building a confinement had allowed children to return to the farm. There was a certain pride in maintaining a livestock operation in addition to growing corn and beans. Farmers

with livestock operations poked half-serious fun at strictly grain farmers. Their labor was required daily when they had hogs, cattle, or poultry, and they worked more and harder than farmers driving tractors and combines for a month or two out of the whole year. I noticed this even in the bodies of people I spoke to. Grain agriculture lent to a more sedentary lifestyle and rounder, softer bodies on farmers, but farmers with livestock were leaner and more muscled, sometimes even bent over on themselves as life had been harder on their bodies. Livestock kept farmers in tune with agricultural rhythms and practices in mental and physical ways, whereas grain agriculture had become more intensively mental and technological.

Even within animal agriculture, there was plenty of variation. The crash in the hog market in the 1980s demonstrates the shift from people's relationship with hogs.

Andy: I started with hogs, a farrow to finish operation. We had hog buildings out here. They were all outside. We had 1,000 hogs. Then the market crashed and it took out the little guys. Now it's just confinements. You know, I can taste that confinement taste in the meat.

[We talked about this, how pastured pork tasted better, how it makes sense that an animal stuck in a building like that would taste like that building. I talked about having pork from Niman Ranch, and how that made a difference. I asked him how the market had crashed.]

Andy: Well, hogs went down to six or eight dollars for one hundred in the late 80s.

Bri: One hundred?

Andy: Yes, six dollars for one hundred pounds. So for a two hundred pound pig you'd get twelve or sixteen dollars.

Bri: Oh my goodness.

Andy: So there weren't farmers selling hogs after that year. We buried the old hog barns.

One of my farmers, Robert, told me he just thought pigs should be a part of every operation because they really had been able to help farmers survive in the past, providing quick money in moments of need like mortgage payments or bills. They were a crucial part of economic and agro-ecological diversification. At another point, Robert's county

had really fought hog confinements, specifically because they had shallow aquifers that didn't have enough water to support hog populations, much less human.

Additionally, several farmers told me it was becoming more common for people to own the land that confinements sat on, and maintain rights and responsibility for the manure, but not the hogs or buildings themselves. Other farmers still owned the buildings and hogs, and had contracts with corporations.

Cattle too created different relationships. In southwest Iowa, there was still a fair amount of pasture because the soil was not as fertile and often very steep (i.e. HEL ground). This could mean cattle grazing and having to be moved regularly across pastures. In the northwest, near where DMWW sued the counties, there were corn-on-corn operations and cattle in more feedlot set-ups. One farmer told me that he was not interested in grass-fed cattle because it meant moving them and not fattening them up as quickly as corn did. Despite the variation in how farmers interacted with their livestock, having livestock created a different kind of operation and set of farming practices. Cover crops, for instance, were framed as having somewhat more resonance for cattle farmers, although as the farmer above said, not everyone wanted this.

Economic diversification could then lead to ecological diversity. The common tactic of finding economic benefits behind conservation practices made even more sense to me then, although there is a large literature discussing the pitfalls of the turn to "ecosystem services" and other economizing strategies for determining ecological values. Nevertheless, materialities outside of the corn paradigm required more labor but created more security, attention, and openness.

3.5b The limitations of the grant: Nutrients

The granting agency and partnerships define much of what watershed projects were able to do in terms of conservation. Many of the coordinators and water-specific conservation experts I spoke to felt the foci of certain grants was limiting. As Marina the water conservation specialist said to me, these grant programs were redundant and kept reinventing the wheel, purporting to be new in their approach. Additionally, if the grant defined conservation in a particular way—such as reducing nutrients and getting waterways off the impairment list, these definitions limited flexibility and scope of the projects. Conversations with Marina and Haley illuminate the intricacies of these programs.

Marina described how Iowa has been addressing water quality problems with the EPA's 319 program since the 1980s, but water quality had not improved. 319 cannot address issues beyond impairments. WIRB was created to be more flexible, yet it was still not working. Now WIRB has been replaced by WQI (Table 3.2). Marina expressed skepticism of WQI because it was the same program under a different name. There was more money now perhaps, but to what end? WIRB had \$5 million in the beginning, but it kept getting zeroed out. During my fieldwork it was down to \$1 million. Projects must show success, Marina emphasized, and had very specific parameters for defining that success (Li 2007a and 2007b; Scott 1998). She predicted WQI would have the same problem with showing success as WIRB and 319.

Haley, a watershed project coordinator, described the parameters of her project to me. Its status had to do with current uses—primary contact recreation, fish conservation, aquatic life, but not drinking water, which would change its status. She reflected that this was part of the issue, that the grant focused on designated use rather than overall water

quality. The way her project's funding was structured focused so heavily on phosphorous and sedimentation. It created this disjointed feel to their approach. 319 funds do not cover nitrogen or talk about nutrient management, and her water sampling did not include nitrogen. It focuses only on what caused the impairment, and water quality downstream was not considered. She could only take credit for phosphorous and sedimentation drops. Despite her training in ecology, which considered scale and connections, she admitted the 319 reporting limited her.

Table 3.2 Overview of Some Water Quality Grant Programs Used in Iowa

Name of Grant	Acronym	Agency	Focus	Status at time of fieldwork
Water Quality Initiative	WQI	State (IDALS)	Nutrients	Active
Watershed Improvement Review Board	WIRB	State	Flexible	No new applications
Section 319	319	EPA	Impairments	Active but budget cut significantly
Mississippi River Basin Initiative	MRBI	NRCS	Flexible	Active but budget cut significantly
Watershed Management Authority	WMA	Various stakeholders (usually SWCDs and towns)	Watershed planning	Some funding for plan, not for implementation

The focus of WQI was nutrients and was based on the NRS. Several people told me the NRS seemed like an attempt to make Iowan farmers look good by connecting conservation efforts to something monumental like the dead zone, and they resented the lack of attention on local rivers and lakes facing environmental degradation. The IDNR had a role in the point source pollution guidelines, but IDALS worked on the nonpoint source pollution sections. This, to one participant, seemed like controlling the message

about nutrients, as well as the scope and focus. One conservation expert told me about a grant they had applied for concerning flood mitigation and water quality, and they had been told by people in political positions of power that they could not reference tile drainage or pollution in this grant. They are working on water quality improvement, and they cannot even say these words, she lamented. It shows how hamstrung they are and cannot even function sometimes.

Grants then often put watershed projects in the conundrum between planning, monitoring, and implementing. Implementation received the most attention because showing the amount of money spent on practices garnered the most respect as “successes,” becoming the most legible and rendered technical facets of water quality improvement (Li 2007a and 2007b; Scott 1998). However, many of my participants pointed out that the practices were first come, first serve, and most projects were not able to strategize about the most impactful practices. Certainly, coordinators who had a watershed plan could approach landowners and farmers about particular practices, but cost-share was available to everyone in the watershed. Often the farmers interested in these practices were already doing other conservation practices, and the land in need of the most change and assistance was inaccessible due to skeptical or even openly disdainful landowners and farmers.

A holistic perspective on water quality improvement remained elusive, in part due to bureaucracy and in part due to neoliberal imaginings of the environment. Programs that had tried to be flexible in approaching it (e.g. WIRB) had trouble becoming legible and being rendered technical to the state, as Marina described. Yet when these legibility and technical qualifications were met more to the state’s standards, conservation experts

were limited to specific aspects of water quality rather than addressing the entire problem. This bureaucratic specialization went in hand with the rise in economizing ecological value (i.e. ecosystem services¹⁷), a trend which has a range of consequences and effects.

3.6 Concluding Remarks

In this chapter, I have explored materialities of the conservation and agriculture of Iowa in order to demonstrate how they co-constitute each other. Agricultural and conservation desires trouble and aid each other. Monoculture is about hierarchy rather than singularity, and it requires labor and care to maintain. Economic niche exploration within the corn and bean system also shows the limitations of monoculture corn as well. The conservation world has tried to deal with the consequences of monoculture, aided by drainage tile and river channelization, with the slow ecological practices, like cover crops, restored wetlands and oxbows, edge of field practices that filter water. It has attempted to bring soil, water, plants and other materialities back into more productive relationships with each other. I also argue that scale is not just made at one level or in one way, that considering materialities can demonstrate scale, as well as troubling the idea of naturalized scales. The scale of a farming operation is also made through a farmer's economic relationship to the land, in terms of ownership and renting, not only through its size. Similarly, watersheds are made through the labor of those working on conservation projects. It also introduces shared infrastructures and domains for de/reterritorialization within and between the assemblages, such as cost-share programs for conservation projects and the maintenance or shifting of the corn-soybean agricultural system. Most conservation work in Iowa is with agriculture, and many farmers navigate, in discourse

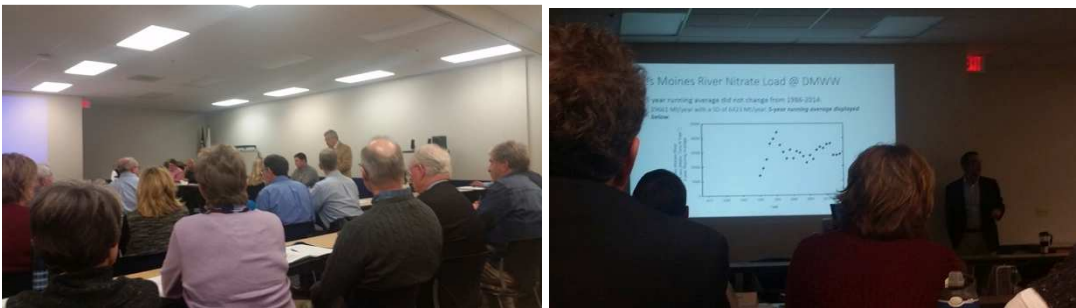
¹⁷ Neoliberalism and its effect on conservation, such as through ecosystem services, are major topics of study, and are beyond the scope of this dissertation.

and/or practice, the calls for conservation on the ground. Within these overlaps and divergences of natural resource conservation and agriculture, drawing on ethnographic data, in the next chapter I discuss how I constructed analytically and empirically two interrelated assemblages, the corn assemblage and the prairie assemblage.

CHAPTER 4

THE CORN ASSEMBLAGE AND THE PRAIRIE ASSEMBLAGE

At a stakeholder meeting of governmental agency representatives, university researchers, and interested members of the public, we listened to member updates on their agencies' activities, and several informative but uneventful presentations on various aspects of water quality (Figures 4.1 and 4.2). Then a researcher got up and asked, could we measure a reduction in nitrates?



Figures 4.1 and 4.2 Scenes from a public stakeholder meeting

I had trouble following this presentation.¹⁸ The presentation asked in its title, was the trend going up or down? The researcher explained there was no statistically significant change over time with lots of variation from year to year. Different graphs came up quickly (Figures 4.2). He used the comparison of the average baby weight going up over a week. Would anyone link that fluctuation to anything but a random pattern? This was

¹⁸ Because this was a difficult presentation to understand, I capture some speech verbatim, and the rest is paraphrased from what I did comprehend.

the “Monte Carlo effect.” Is this just luck of the draw? He emphasized, you can get better numbers in the smaller watersheds.

One agency member asked about concentration versus load. Someone else asked about small watersheds and how long it would take to analyze. Another person asked about modeling versus the real trend. The agency member said, this is about predictability using previous data.

Then a member of the public spoke up, his voice mounting with anger. He said, “What is the point of this kind of analysis? You are just selecting the data you want when the data is already there. We have it. Why do we have to use models that make it sound like we can’t know what’s happening?”

The presenter said, “I’m just trying to find out the truth.”

The audience member said, “I don’t think you are.”

The presenter stood uncomfortably, as the uncertain silence settled on the room briefly. Without addressing this tense exchange, people moved into discussing plans for future presentations to the group and future projects.

This moment was one of many that demonstrated to me the tensions in Iowa occurring over nutrients, particularly nitrate. A researcher who I had heard speak before, on different findings with more clarity and more explicit calls for change, now sounded mild and gave a confusing presentation to these stakeholders and members of the general public in attendance. He destabilized, or deterritorialized, science’s ability to model or measure how nitrates would behave, and unpredictability on the part of nitrates, as Chapter 5 discusses, is an important strategy for redistributing accountability from agriculture to Mother Nature. Had the researcher changed, or changed for his audience?

What would have happened without the challenge from the audience member? The audience member reterritorialized science's ability to measure nitrate. My notes do not indicate whether the presentation was about modeling possible trends in nitrate or measuring real quantities, but I do know without this reterritorializing information, I would have left confused about measuring nitrates. I wanted to be able to describe the different relationships in a room like this one, able to represent assumptions, hopes, and strategies in particular contexts. These types of exchanges encouraged me to consider the assemblage again as my unit of social organization. While no one in my fieldsites would use the prairie assemblage or the corn assemblage to describe themselves, this etic framing gave me insight into what was happening in Iowa in a way that emic terminology did not.

The flexibility and fluidity of the assemblage felt right and made sense. But how could I utilize it? It was slippery as I tried to identify essential actors and core desires shaping the assemblages that mattered in my fieldwork, and what made them different. Yet returning to my data, I found people in interviews and at events oscillating between and within assemblages. Additionally, only being able to speak directly to people, it was easy to lose sight of the nonhumans that also mattered in each assemblage. Therefore, I found it worked best for me to consider the assemblage as an analytic through which I could examine imperfect patterns of belief and behavior, as well as connections between various actors (people, vital entities such as prairie and corn, vital technologies, and infrastructure).

As I mentioned in Chapter 2, I originally came to Iowa to document what I imagined as the hypoxia assemblage, actors coalescing in various efforts to reduce

nutrient flow causing the dead zone in the Gulf of Mexico. I expected organization and collaboration to happen around the Nutrient Reduction Strategy (NRS). The Nutrient Reduction Strategy is absolutely a significant infrastructural actor within the assemblages, but not in the way I expected. It gained significance in the wake of the Des Moines Water Works lawsuit in 2015. To echo Ferguson (1994), what does the NRS do as part of the conservation boundary object, particularly with the challenge issued from a local drinking water utility? This chapter explores the messy contradictions arising from the interaction of these two event-entities (i.e. the NRS and the DMWW lawsuit).

In Iowa, my participants continually referred to a divide, both material and ideological. Maya, a conservation expert, indicated that the lawsuit “broadened the urban-ag divide,” while Corey, a grain and hog farmer, said that “the public is the number one enemy [to farming].” In addition to an ideological and informational divide along murky agricultural and urban lines, people often referred to the continental divide where water flowed to the Mississippi River or to the Missouri River. Jokingly, Matthew, an older and reflective farmer, said, “Our land is on the other side of the continental divide here, so we go to the Missouri. So we don’t have to worry about it...that’s their problem.” Jeff, a row crop farmer in the same area as Matthew, told me there was a divide in terms of discourse and responsibility along I-35 (which runs north to south) at his producer association’s board meetings, where farmers east of I-35 said, Why are we dealing with our water quality problem over there, and you farmers don’t know how to farm over there. He shook his head at this in frustration.

However, the nature of this divide was not always clear. What was the nature of this urban and agricultural divide, or the public versus farmers, farmers versus farmers, or

the Missouri River versus the Mississippi River? It proliferated. It shifted from extreme and radical difference to one that was barely perceptible. It jumped scales. It was a multiplicity, all these tensions present at the same time, in the same room. These tensions demonstrated to me that what I had originally thought was a single form was in fact better represented by two interrelated and interacting assemblages that revolve around axes of distinction in Table 4.1. Actors participating in these assemblages both aim to live well in Iowa. Both assemblages have definitions of land stewardship. Actors in each make claims to powerful sources of symbolic authority, grounded in legitimized forms of knowledge production and spatial-temporal histories of the landscape. Yet each assemblage identified different problems preventing living well and utilized different strategies for achieving it.

Central to both assemblages is the desire to enact conservation. Conservation then is the boundary object with which the assemblages try to make Iowa livable and lively. What needs to be conserved, how to do it, and why it is necessary tenuously separated the assemblages into the corn and the prairie assemblage. Both farming and the Iowan landscape, inextricably linked, were and are threatened. They could be each other's salvation as well, but often they are trouble for each other (see Chapter 6 and 5, respectively). The corn assemblage moves toward the desire of the present and future prosperity of the farm: ultimately, continuity. The prairie assemblage moves toward the desire of the revival of a perennial biodiverse landscape: ultimately, change. The NRS and the DMWW lawsuit both propose alternative infrastructures for how to achieve conservation, voluntary participation and regulatory compliance respectively. The NRS was the actual infrastructure while the lawsuit summoned potential infrastructure,

echoing regulations from other times and places (e.g. the 1985 Farm Bill and the Chesapeake Bay). In other words, the conservation boundary object mainly had infrastructure based on voluntary compliance in terms of landscape revitalization. In terms of farm continuity, the question of infrastructure was more complicated, as my discussion of scales of farm operations and brief discussion of hog confinement demonstrates. Through territorializing efforts, work within the assemblages tried to legitimize or delegitimize the ideological premise and material implications of the NRS and the DMWW lawsuits, depending on the presumed effects on their desires.

Table 4.1 Regularly cited tensions on the Iowa landscape

<ul style="list-style-type: none"> • Rural versus urban • Farmer versus non-farmer • Prairie versus corn and soybeans • Wetlands versus drainage tile • In-field conservation versus edge of field conservation practices • Public land versus private land • Emotions/politics versus science • Individual versus universal E.g. “Every farm is unique.” versus “Iowa is meant to grow corn.” • Biology versus chemistry versus physics E.g. Solutions via soil biology versus pesticides and fertilizer versus tillage • Regulatory/litigation versus voluntary/collaboration • Des Moines versus Cedar Rapids • NRS versus DMWW
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The average age of an Iowan farmer is 57.1 years old (USDA NASS 2017). More landowners are absentee and do not farm themselves, which means most farmers have to rent. As was addressed in Chapter 3, those children who do want to farm do not have access. Or their families deal with difficult farm transition decisions. For those children who simply do not want to farm, their parents do not want them to either. High land

prices provide parents' retirement and children's inheritance. Inheritance becomes an issue when non-farming children want their share of the million(s) dollars operations. Although Iowa has the constitutional clause that families, not corporations, can farm, corporate control has emerged in the livestock sector. In the grain sector, large operations with kin and non-kin employees have the competitive edge in paying rents. Although government programs support corn and soybeans through crop insurance, being able to find land to rent and farm, low market prices, and high capital investment make the ability to farm the next year uncertain. Industrial farming is unstable and risky, as prices rise and fall, as debt and capital is accrued, and as technology brings innovation and restrictions. Consolidation, both within the corporate agribusiness sector as well as operations themselves, makes it even more precarious.

Original prairie, Iowa's historic ecology, has been reduced to less than 0.1% of Iowa's landscape when it used to cover 85% of the state (US Fish & Wildlife Service 2012). Wetlands have been drained for agricultural production. Restoration of these landscapes is marginal, in percentage and type of land, and restored projects cannot compare to original ecologies. This reduction has implications for biodiversity broadly, but it is more critical than that. Anthropogenic changes to the landscape have meant the decline in these ecologies' abilities to biologically process what have now become pollutants. As was outlined in Chapter 3, tillage disrupts the insect-fungi-microbe ecologies that make up the soil, making a less lively if not completely dead zone in the soil. Rain either runs off the top of sealed-shut soil that used to be a porous filter, or it runs through the cracks into drainage tile. Drainage tile gives water a direct pathway into waterways rather than filtering through the soil profile and plant roots. Also recall that

waterways have been channelized, losing their meanders that slowed the water down and allowed diverse species, such as mussels and beavers, to process nutrients. Iowa is thus now a landscape of speed, a feature presumed equivalent to efficiency, with water rushing off and out, crops planted and harvested as soon as possible, pests attacked aggressively and quickly. Many species cannot compete or keep up with the demands industrial agriculture places on the landscape.

Despite recognizable divergences in the assemblages, as people would position themselves in opposition to each other, it was unclear to me how to describe these oppositions within my analytic framework. My data revealed that participation in an assemblage was thin, contradictory, and complex. Actors could be in *both* assemblages. Sometimes they leaned into the moment of one assemblage more, making them more entangled there for a day or lifetime. As the two assemblages met, some actors yearned for both the continuity of farms and revitalization of perennial, slow ecologies. Despite dual yearnings, aspects of each assemblage had power, internally and externally. Ultimately, people's ideas may display one desire, and their actions demonstrate another. It is not for me to parse out how members contributed to the furthering of each assemblage's desire but rather to show the patterns, frictions, and gaps for the creation of each assemblage. Neither the prairie nor the corn assemblage mapped onto a particular livelihood or system. Prairie assemblage actors, for instance, did not include all conservation professionals or conservation practices. Similarly, not all farmers were actors in the corn assemblage.

Within this chapter, I discuss, how—through territorializing movements around the Nutrient Reduction Strategy, the Des Moines Water Works lawsuit, and their

interactions—each assemblage made sense of themselves, each other, and these entity-events in their slippery, gapped, knotted ways. Patterns of how I could imagine these assemblages emerged when I considered how different human actors interacted with the NRS and the lawsuit. Actors in the corn assemblage considered the NRS worthy as a whole document while the lawsuit was subject to critique from numerous angles. So conservation practices spanning from edge of field to in field—bioreactors to cover crops or nutrient management—could proliferate on a NRS-mediated landscape, while nitrates became suspect and tile became invisible. Actors in the prairie assemblage critiqued both the lawsuit and the NRS, considering how each made it difficult to achieve change through conservation. In this assemblage, certain conservation practices—anything encouraging liveliness of soil or water (e.g. cover crops, no till, wetlands)—became the most crucial and central vital entities and nonhuman actors. However, unlike within the corn assemblage, prairie assemblage actors did not critique the premise of the lawsuit but rather its consequences. Tile was visible, a troubling companion and vital technology, but tracking it was such a massive scale-making project that it drowned out possibility of nitrate reduction. Instead, tile summoned the specter of increasing bureaucratization, imagined through more reports and more rules governing (and failing to revitalize) the landscape, rather dispersing human-led conservation grounded work into paper pushing. The NRS and DMWW lawsuit expressed a similar desire: finding strategies to reduce nitrate flow into waterways. However, each proposed radically diverging infrastructure to do this, and each lends itself differently to the desires of the assemblages.

4.1 Building Assemblage: The Nutrient Reduction Strategy and DMWW Lawsuit

The Nutrient Reduction Strategy is positioned as a framework based in both science and technology to assess and reduce the introduction of nutrients into waterways

within the state and beyond (Iowa State University). It emphasizes finding scientific, reasonable, and cost effective approaches to nutrient reduction. The part of the NRS that addresses nonpoint source presents multiple nitrogen and phosphorous reduction practices, and the percentage reduction farmers could expect based on the scientific team's literature review (Figure 3.15). The intention is for farmers to pick what will work for their operation, hence the oft repeated phrases, "toolbox," "suite of practices," and "silver buckshot" to describe the NRS. The NRS itself is a multiscalar—national, regional, and state—and collaborative document. It arose from the collaboration between the EPA and Mississippi Basin state agencies to reduce nutrient flow contributing to the dead zone in the Gulf. This began in 1997.

In 2011, the Secretary of Agriculture and co-chair of the Hypoxia Taskforce, Bill Northey, came to the dean of College of Agriculture and Life Sciences at ISU, saying Iowa must lead the way on hypoxia. The dean said, "Get the scientists together." And they came—from ISU, USDA Research Service, IDALS, IDNR, NRCS, and even a few scientists from Minnesota and Illinois would phone into these meetings.

The director of the Nutrient Research Center at ISU described how these teams worked. They formed a nitrogen (N) and phosphorous (P) team, headed by N and P team leaders, who worked in-between. For two hours twice a month, the teams discussed the literature reviews they had conducted to explore what had been published, identifying and assessing various studies within the parameters of what was useful to the NRS. They hired a staff person half time to organize the spreadsheet and do the literature review, and a professional writer edited their part of the document to conform to a single voice and format. It took over two years; they started in August or September of 2010, and the first

draft was released to the public on November 2012. After minor revisions in May 2013, the NRS had a 60-day period for public discussion, resulting in over 1,700 comments. The comments divided into two main camps, about even in the stacks, for and against, with formal comments on science as well. I asked what the two stacks were. The director stated the main disagreement revolved around a regulatory versus voluntary approach. The voluntary stack said, farmers care for the land, but they just need time and money to do it, so keep it voluntary. The regulatory stack said, you already had several decades to do this, it was now time to hold farmers to account. Then, there came a third way, unrelated to the NRS.

In 2015, Des Moines Water Works (DMWW) announced a lawsuit that was suing three upstream drainage districts encompassing three rural, primarily agricultural counties. DMWW staff had collected water from tiles throughout these counties and sent them for analysis to the Iowa Soybean Association (ISA), without telling ISA about the origin or intended purpose of the samples. Local farmers described seeing the staff, asking them what they were doing, and staff evading them. The samples collected went to the lawsuit's argument that farming practices were polluting waterways with high levels of nitrates, and that drainage tile should be considered point sources rather than nonpoint sources by the Clean Water Act's definition.

By the time I began my interviews in the North Raccoon and Middle Cedar watersheds in 2016, the lawyers were making arguments in the courts, specifically around the issue of whether drainage districts could be sued. In the late fall of 2015, I toured the DMWW facility with a large group of farm conference attendees. Our tour guide wound us through outside facilities, to the biology lab, into the chemistry lab, inside the echoing

white filter house, and next to the nitrate removal tanks. In the biology lab, we saw lively water projected on a screen that the utility cleans, despite only a few microbes being harmful. In the chemistry lab, the head chemist showed us printouts of chemical compounds in water samples, appearing as sharp peaks and tiny bumps on the graphs. The utility pulled from the Des Moines River, the Raccoon River, and the gallery, a groundwater collection area that filters naturally. Our guide stated that DMWW was in the public health business and was a company that cared. For example, he said, they had asked people to curb water use. They aimed to provide a safe product, so they must clean source water and make sure it arrived to people's homes and businesses cleanly.

Then we arrived at the site of all the contention. The nitrate filtration building was built in 1991 and became operational in 1992, one of the largest facilities. Enormous green tanks removed nitrates (Figure 4.3).



Figure 4.3 Nitrate removal tanks at DMWW

Inside the tanks was a beadlike resin with chloride ions, and the resin absorbed nitrate surrounded by their chloride surrendered in an anion exchange. In one day, the resin was tired and needed to be regenerated, so the utility took the vessel offline and

cleaned it by bombarding the resin with brine solution. This anion exchange happened again in cleaning. The regeneration waste presently went back into river, but they were trying to redirect wastewater plant. Anticipating the question, the guide dismissed the idea of using this nitrate-laced solution on farms. The water generated was between 150,000-400,000 gallons, and the idea of driving a truck with a tank and applying it somewhere...He trailed off to show the absurdity of this proposition. The nitrate solution put back may be undetectable, but the philosophical point still resonated with DMWW, he declared. Water went past us with nitrogen, but we only take 25 million out of 100 million gallons. But how different were we than other people, putting nitrogen back?

The west DMWW plant used different water sources and required no nitrate treatment, and the other plant used reverse osmosis to remove nitrate through a membrane. The utility's decision calculated which sources to use based on issues like nitrate levels and the cost of treatment of particular source waters. Some people wanted it all removed, and they may have a point, our guide said, but there were operational and cost issues. Our guide ended the conversation of the subject with this, "Me? I think I didn't put it in there...it's not my issue." DMWW was incurring costs because of nitrates. The Des Moines River was more expensive as the first choice because of nitrate levels.

I heard the CEO and Director of DMWW, Bill Stowe (Figure 4.4), speak at several events, on his own and as a member of various panels. At the Organics Conference in Iowa City, he had the floor to himself. After the introducing speaker emphasized Stowe's legal and scientific backgrounds as an environmental engineer with a law degree, framing his authority, Stowe opened with the affirmation that, "farmers were source of nitrate problems." We have a water crisis by three measures, he said. It

was not just weather, drought, and geese as ‘other members of our community’ might say. This crisis could be measured by, number one, impaired waterways. Number two, beach closures. And number three, high nitrate concentrations, currently breaking records. He addressed the crowd: Most of you know hypoxia is waxing, too.

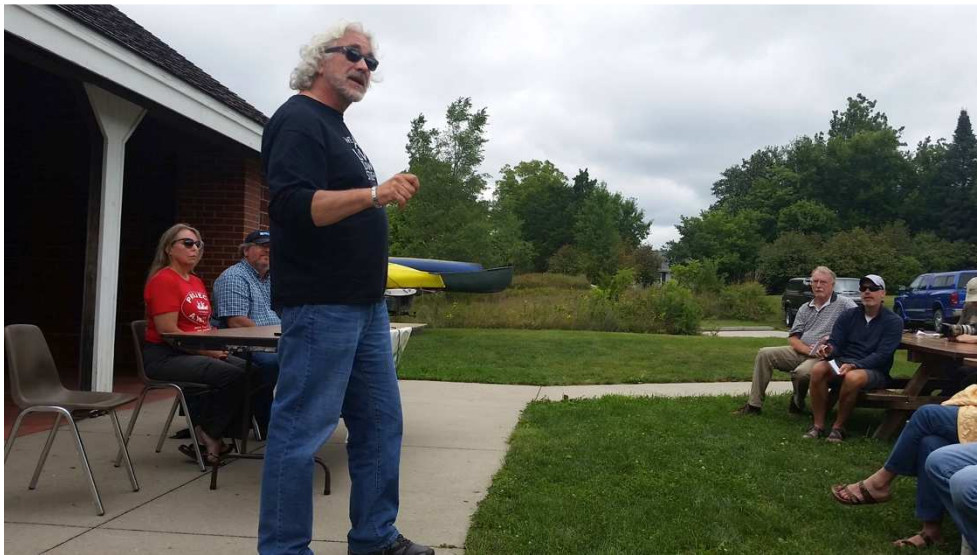


Figure 4.4 Bill Stowe in action at a public meeting in south central Iowa

He cited other communities affected by water issues: New Orleans and Gulf Coast marine folks; Charleston; California; Toledo, Ohio which was under a do not drink order at the time. “A number of our community is haunted by high nitrates. Overnitrification occurs due to land uses effect on water, not geology. Tiling is the main concern. With an increase in water quantity, there is a decrease in water quality. Water moves laterally. The voluntary approach is a failure. They saw we need more time, but you’re gonna be thirsty today.” Stowe, in a broad sweep, put Iowa’s water quality issues in a national context, and he put the responsibility squarely on agriculture and farmers.

His no-nonsense eloquence earned him admirers and enemies. For example, the whole issue inspired a novel by Jennifer Wilson (2016), *Water: Love Polluted by Politics*

and Power Plays! This Sexy Romp Filters the Nitrate Wars through the Soil of Lust and Lost Ideals. The company that published this book, RAYGUN, created t-shirts stating, in bold block letters on light blue cotton, “I’M WITH STOWE.” On the flip side, the lawsuit also inspired angry legislators to create a bill to redistribute control of the utility to local municipalities rather than mayor-appointed board members (Elmer 2017).

A professor of environmental health speaking at the Organics Conference summarized one common position on the NRS-DMWW lawsuit conundrum well. If you thought lawn care was the problem, that was wrong. Corn loved nitrogen. Seventy percent of nitrogen went from agriculture to the dead zone. The NRS was introduced in 2013, and they worked on it for two years. He cited the Iowa Farm and Rural Life Poll done out of Iowa State, and a question which asked how much farmers spent on conservation. The figures he quoted claimed 51% said none, and 21% for less than \$5000.¹⁹ “The strategy,” he concluded, “does not give me much confidence.” This was not about the NRS or hypoxia. Des Moines Water Works and Toledo would make changes, he predicted. The professor mirrored Stowe in his location of blame and responsibility, and believed that lawsuits and life-threatening toxins could make changes, not voluntary frameworks and dead zones.

At a producer association conference, a director involved in environmental services framed the issue in this way: The planet could support nine to ten billion people, and no further growth after that. We needed to feed, cloth, shelter, fuel, and grow for the world, but we also needed the prosperity and health of the environment. He listed some

¹⁹ When I checked the Farm and Rural Life Poll for that specific question, in 2015, the numbers I found were 12% of farmers had spent nothing on conservation, 30% of farmers had spent \$5000 or less, and a little less than 18% had spent between \$5000 and \$10,000 on conservation in the past 10 years (Arbuckle 2015).

numbers: 1600 HUC12s, 88,000 farms, 947 cities, and 32 WQI (Water Quality Initiative) projects. It was an interrelated system, he said. We need a new policy and paradigm. Nutrients are complex so it's going to take investment of time and money. The NRS could help us address Iowa water and the Gulf of Mexico. The NRS was the catalyst, the rallying call, and this was the chance to champion that. Water connected us all. Water drove the quality of life and prosperity. There needed to be a paradigm shift, a One Water approach, comparable to the moon shot. One Water was all about integration, and urban and ag coming together, no lines between them. He referenced the Hypoxia Taskforce and Cedar Rapids as positive examples of collaboration.

He said, we were all aware of the nutrient challenges. We had to also deal with century-old water infrastructure, especially in urban years, well past its useful life. There were 650 water main breaks per day. The Army Corps of Engineers gave Iowa a D in water quality overall. Quoting *The Atlantic*, we had to find the right price for water. Water could become economic gain.

Despite agriculture's scale on the landscape, the director tried to equalize blame and responsibility through several logics. He emphasized the scale—spatial and temporal—of efforts needed. He used discourse that enrolled urban populations into the One Water paradigm (i.e. urban water infrastructure), the need for “everyone to work together,” a common refrain in Iowa. He also drew on the economic turn in ecosystem services, that it was all about find the right price and value for ecologies. In essence, he absolved farmers of all or most of the blame put on them through discourses like Stowe's and the environmental health professor by enrolling “everyone” as participants in improving water quality.

Both Stowe, the professor, and the producer association director performed ideologies that I often witnessed in public. Within these ideologies, they drew hard lines around causes and necessary steps. However, in my ethnographic data, I witnessed more uncertainty, partial perspectives, and ambivalence. It was within this emotional, political, scientific, and ecological intensity that I first witnessed the emergence of the corn and prairie assemblages.

4.2 Building through Critique

Actors in the prairie assemblage critiqued the NRS, while actors in the corn assemblage primarily critiqued the lawsuit. Actors also critiqued the lawsuit's impetus: the creation of regulation. But within each assemblage, there was a different reason for doing so.

Since the prairie assemblage actors primarily advocated for change, they found the NRS lacking and aimed to deterritorialize it by pointing out its inadequacies as a "strategy." Nathan, a lean tall conservation expert with a soft and pensive affect, said about the NRS, "To the extent there is a strategy. They're just giving people money to do stuff." He added with frustration that farmers still would not participate. People acting within prairie assemblage questioned the fact that there was no timeline and no standardized and required measurement of the effects of these practices. The state had created the watershed demonstration projects to address the NRS. Yet, while some projects did provide waterway and tile monitoring, this was not a goal embedded into the NRS. Overall, because participation in the NRS was not required, the prairie assemblage questioned its capacity to be effective.

Similarly, the state had provided no source of sustainable funding to address water pollution. Alice, a Soil and Water Conservation District (SWCD) commissioner,

lamented that these watershed projects were grant funded. The Iowa legislature had not funded the Natural Resource and Outdoor Recreation Trust Fund—a 3/8ths of a cent sales tax going toward funding for water quality and parks projects—nor were they agreeing to find or create other sources of money. Similarly, Marvin, another SWCD commissioner, stated the “the difficulty with the projects is when a lot of money has gone in, they do work. [We have to be] careful. As projects wind down, [and the] cash cow is gone, we need to find a way to make sure...as the sun sets on [this] thing, sun rise [also] happens.”

To highlight the inadequacies of the NRS, many actors in the prairie assemblage drew comparison to surrounding states’ approaches to addressing conservation and water quality. Austin said, “Everyone around us, every state, has a funding mechanism. Minnesota, Missouri, Nebraska. Not sure about Illinois. [But the others have] some way to fund it.” Minnesota came up frequently as an example. An environmental engineer cited Minnesota’s water rich culture (which others contrasted with Iowa’s farming history and pride) that encouraged a tax-supported watershed project system that rotated focus and resources to a different HUC8 annually, as well as a fifty mandatory grass buffer along all waterways. Several people told me about Missouri’s sales tax that supported their parks and conservation initiatives, and, one of my research participants said, Missouri, which is an agricultural state, voted to renew this tax.

Within the prairie assemblage, there was a strong preference for particular practices within the NRS. Not all conservation was created equal, and human actors in the prairie assemblage dismissed practices such as nutrient management as having marginal impacts for the vital entities like water or farmers’ perspectives and practices.

Rather, they cited practices that fundamentally changed the landscape: cover crops in-between cash crops, prairie strips in and around the fields, a third crop rotation, restored wetlands, and reduced or no tillage of the soil. These practices all encouraged lively landscapes. Still, even programs like CRP (Conservation Reserve Program)—ten to fifteen-year contracts for seeding fields to grass—had limitations. This would seem like a favorable practice since it gave the ground cover and rest. However, farmers would pull land out of CRP in times of high grain prices, and the fields were rarely multispecies plant ecologies echoing the prairie. The prairie assemblage was more ambivalent about edge of field water cleansing technologies, like bioreactors—pits full of nitrate-removing wood chips—which were temporary and limited in acres treated. Saturated buffers diverted tile line water horizontally along stream banks to give the water a chance to filter through the soil profile, but these provided little other ecological benefits and bypassed the system in times of heavy flow. Still, in achieving environmental results, actors in the prairie assemblage would draw on whatever practices of the NRS where the landscape became a priority. Providing a hierarchy to practices the corn assemblage would frame as a toolbox was another process of deterritorialization. Similarly, prairie actors would reterritorialize the landscape revitalization through promoting and using lively-inducing conservation practices.

Alice summarized the problem most of the prairie assemblage expressed, “[The] Nutrient Reduction Strategy was needed. It's scientific based. Forty-five percent reduction is hard slog. There is no teeth in it. It's just a framework.” The NRS had no long-term, sustainable infrastructure to support either its implementation or documentation of results. Actors in the prairie assemblage identified the missing and

weak affiliations surrounding the NRS, specifically its lack of infrastructure to support implementation and results, and arranged the practices from best to marginal in positive impacts for water and the landscape. Deterritorializing allowed actors within the prairie assemblage to imagine and advocate for additional infrastructure to support the NRS, such as sustainable funding (e.g. the IWILL sales tax legislation), statewide monitoring programs, and prioritization of particular conservation practices.

When I asked corn assemblage actors about the NRS, they often described their experience through particular practices to me. The NRS then was treated as a whole entity to them; its framework was not something to be questioned. The corn assemblage then tried to stabilize the NRS as infrastructure, so actors reterritorialized its utility in several ways. First, they emphasized the uniqueness of each operation, so the strength of the NRS was in all of its options, which fell in line with the dominant metaphors of “the toolbox,” “suite of practices,” and even “silver buckshot” to indicate all the available tools and approaches. The NRS allowed farmers to claim conservation more easily without significant land management changes or loss of farmable acres, while the prairie assemblage centered particular practices as the most important. The local definitions of the conservation boundary object were apparent through each assemblage’s analysis of the NRS. Any of these practices could promote corn assemblage desires because regulation, what the NRS defended against, affected the continuity of farms. Only specific practices could actually revitalize the landscape according to desire within the prairie assemblage, so the NRS was useful only in part.

Second, the corn assemblage used the NRS as an example of collaboration and a call for equal participation from all Iowans, contrasting it with DMWW’s litigation.

Hypoxia then became a discursive tool to show alliance with a voluntary approach to improving water quality. By acknowledging a connection to Louisiana and the Gulf, human actors within the corn assemblage could demonstrate care for the water while simultaneously attacking other methods of care (i.e. litigation). The lawsuit, as I will discuss, targeted waterways within the state, rather than the Mississippi River or the Gulf. Corn assemblage actors took this as a personal attack, and many told me that farmers did not want to lose precious nutrients or pollute precious water resources that they and their families also drank. Actors enrolled the hypoxic zone into the corn assemblage to do ideological work and demonstrate their knowledge of ecological relationships.

However, the NRS was not beyond critique within the corn assemblage. Generally, actors brought up the fact they needed proof these practices worked on the Iowan landscape, touted for its different soil types, topographies, and climates (Li 2005; Scott 1998). Although the NRS is a scientific document, human actors in both the corn and prairie assemblage framed this as laboratory science, divorced from the particularities of farming operations and their landscape contexts. Farmers specifically said they wanted evidence that these practices worked, instead of financial incentives, which often meant neighboring farms with similar landscapes and managements must show success with a practice. Economic calculations were estimations, and agronomic benefits seemed uncertain as well.

Even if the scientific, economic, and agronomic aspects of these conservation practices had all been more predictable, the sociocultural aspect—would a farmer even be willing to change their practices?—was not. Many people told me about the conservation-minded farmer, the low hanging fruit, and the early adopters and innovators.

These were the farmers primed to try new things, specifically in conservation. But there was a silent majority. Smith, a conservation expert in the business world, discussed the reach of the conservation in this way:

The head of NRCS has said they work with ten percent of farmers a year. That may be too much, it may be only five percent. And I've heard [it's] only two percent of the land, they don't even treat all of the land. So NRCS is working with a farmer every 10 years. By any level that would be failure in business. And most people go to NRCS are repeat clients.

Some people considered this majority to be cautious and awaiting results, while others imagined these farmers simply did not care about conservation. It was simply unknown what the spread looked like in terms of farmers' willingness to change to more conservation practices. The landscape's uniqueness and farmers' operational knowhow then became a way to soften the infrastructure of the NRS as well, to deterritorialize even as reterritorializing it was in the corn assemblage's interests.

People I would have labeled as corn assemblage actors also mirrored critiques that the prairie assemblage actors expressed. Clint, a farmer who saw no purpose behind the lawsuit, said to consider this about the NRS, "Young college kids [in charge of watershed projects] don't know what works and what doesn't. Throw money at programs that are questionably put in place. End result is not going to be much." Clint brought in the youthful, non-farming backgrounds of many watershed project coordinators and the lack of prioritization and infrastructure, similar to the prairie assemblage's framing of the NRS. So despite the general division in the NRS critique I witnessed, assemblage enrollment remained flexible, differences made by degree rather than in kind.

In regards to the DMWW lawsuit, actors within the prairie assemblage seemed ambivalent. Overall, actors did not attempt to deterritorialize or reterritorialize the

lawsuit. It had made some of the actors' conservation work with farmers more fraught and difficult while facilitating new relationships in other cases. Regulation was not something many prairie actors wished to strengthen because of the lack of actual and potential infrastructure to support this approach. However, they did not deterritorialize the premise behind the lawsuit, acknowledging, from their perspectives, the legitimacy of the claim. Corn assemblage actors dismissed the lawsuit's legitimacy by calling it a political endeavor. Rarely did corn actors contend with the lawsuit's argument that tiles should be re-categorized as point sources rather than nonpoint sources, which would make it easier to attribute blame and hold farmers to account. Tile was naturalized as part of the landscape, necessary and inevitable. Instead, they questioned Bill Stowe and the utility itself. The corn assemblage then aimed to deterritorialize the lawsuit as a whole, because, from a corn perspective, the lawsuit threatened reterritorialization through the NRS and corn assemblage desires.

Melvin and Lucille were a farming couple from the North Raccoon with a background in the legislature. I sat at their kitchen table as they finished ice cream from their lunch. Lucille is a stern and upright woman in her late 70s, and Melvin, leaning back into his chair and suspenders, was an 80 year-old big bellied man with appraising eyes and a raspy radio announcer voice. He was the same farmer who interviewed me before I could begin my interview (Chapter 2). When I asked them about the lawsuit, Lucille began,

It's interesting the choice of location that they picked. After the suit was filed, people knew staff members from Des Moines once a week, every two weeks, were measuring water coming out of the tile lines. Building a case for where they wanted to be.

Lucille signaled the politics of the lawsuit, questioning the choice of location, and

framing water quality testing as building a case rather than doing science.

But you think about Des Moines...The cheapest way to take care of those nitrates is to empty them back in the Des Moines River. If you use that comment, the solution is the dilution, it was not a problem when they emptied those into the river. It was a problem they passed on down the river. But they're picking a location at the very top end of the Raccoon River. That water is coming out of those units at over 10 ppm when it goes into the river. It's still at that same level. Well, there's lots of water that dilutes in-between. They're stretching reality on that being the original nitrates from Sac County.

Lucille, using the poetic phrase, "the solution is the dilution," questioned the ecological relationship. Were the nitrates not being diluted as they ran from Sac County to Des Moines? Was that not what the utility did, dilute nitrate to the drinking water standard? She also implicated the utility in mirroring farmer behavior by dumping nitrate-filled water back into the river.

And then the other part of it is we've been told...they picked a location far enough away from Des Moines, it wouldn't upset local residents because these people would be too far away to [be] upset. Wouldn't upset people in Des Moines. So there's two parts to why they picked Sac County.

Lucille drew in two common aspects of critique of the lawsuit common to the corn assemblage: the rationale behind choosing these specific counties to sue as well as the actions of the utility, with the river mediating between the two. Farmers and farm practices remain absent from her account, giving no legitimacy to the claims made by DMWW. Sitting quietly but poised for his turn during his wife's appraisal, Melvin then followed up with,

Melvin: Do you know Bill Stowe?

Bri: I've met him.

Melvin: Does any of the information you collect go back to him?

Bri: No. It's all confidential.

Melvin: Okay, good. It would be kind of fun to go to court against Bill Stowe. So many loopholes in his argument. He says it's mandated he pulls the nitrates out. Puts them back in. I don't know if that's required or not. He says he has to.

In this moment, I was suspect as a possible informant to Stowe, where I collected information for him through my interviews similar to the way Lucille described DMWW employees collecting water from Sac County. I briefly managed to escape this role, but as becomes apparent below, not for long.

Lucille: He has to dispose of them somehow.

Melvin: Why don't they put them out on farm ground?

Bri: I did a tour of DMWW. They were taking it out and not putting it back [in the past]. Then DNR said you couldn't.

Melvin: What kind of quantity? Form?

Bri: Liquid. It's in a solution. It's not a usable form.

Melvin: A lot to transport.

Lucille: It has to be converted.

In this excerpt, Melvin, Lucille, and I had entered the courtroom where Bill Stowe was metaphorically on trial. By revealing insider knowledge, I became his representative and proxy. Although I had thought I was merely explaining what I had learned, Melvin took this as a challenge to his well-reasoned poking of loopholes. I continued with trying to explain, unwittingly still on trial.

Bri: They are trying to deal with that too.

Lucille: They take water out of the river, put it back in. They don't use wells out very far from the river.

[**Bri** explains at length about the three sources they use and alternate between for water supply]

Melvin: We ran into this argument about the ability of the soil to filter. It's an excellent filter. Bacteria is less than a foot. 99% of the bacteria filtered out. Why not draw water out a sand point? Did they talk about that at all? On your tour?

Bri: They didn't talk about that. Nitrate was more difficult to get out. Sand filters out bacteria, etc. but not nitrates.

Melvin: Too soluble.

Melvin would concede one loophole, with something akin to admiration of or annoyance with me, and then moved onto his next loophole, where he addressed drinking water standards rather than actions by the utility.

Melvin: Have you ever seen or known anybody with a blue baby?

Bri: No. I didn't even know what it was.

Melvin: When was the last one diagnosed?

Bri: 1970s or 80s?

Melvin: Okay. What is the human tolerance of nitrates, ppm? Blue baby supposed to be 10.

Lucille: That's the first 6 months of life or maybe 2 years.

Melvin: If you and I were drinking nitrate saturated water, how much would we have to drink until it was unhealthy?

Bri: I don't know.

Melvin: Does he know? Did he talk about that on his tour? How did they arrive- Is it just the blue baby thing that's driving this whole thing? We haven't had any.

Bri: That's an EPA standard.

Melvin: That's encouraging.

Bri: Drinking water utilities don't get any say in that.

In regards to the blue baby syndrome, Melvin had thought he had found a loophole I could not address. However, when I explained this was a federal standard over which drinking water utilities had no say, he conceded.

Melvin: Well, okay, Iowa State University is on record. If you had a prairie and were taking water from under the soil, it would average 14 ppm.

Bri: I haven't seen that [disbelieving tone]

Melvin: Bill Stowe is asking us to do something Mother Nature hasn't been able to do. Is that reasonable?

Bri: That one not so much. I haven't seen that study.

Although I was deeply skeptical of this point, Melvin won this round of the argument, granted by science's symbolic authority. I could not sufficiently address the loophole because I simply had not seen the study he cited.

Melvin: I think I'm right on that. I've seen it in print. And that other thing that is happening the drainage district is a taxed area. They have a drainage tax. People using it pay a tax. The supervisors are the trustees. They're the landlord of that district. They collect the tax [to] make sure they are maintained, but that's about what they've had. They're immune from lawsuits in the Iowa Code. So how's this lawsuit going to move forward?

This final round I also lost because I could not answer. This was the question before the courts, and I was curious as anyone to find out the results. Ultimately, it was this part of Melvin's argument—the court's decision that drainage districts are not entities that can be sued—that would be the downfall of the DMWW lawsuit, not the issue of drainage tile as creating point source versus nonpoint source pollution. By placing myself as knowledgeable by going on a tour of the facility, I aimed to answer questions he posed whereas he simply wanted to demonstrate to me the multiple layers of Bill Stowe's folly. Interestingly, Lucille seemed to agree with me throughout this hypothetical court appearance, a jury member making sense of the arguments in front of her.

In terms of Stowe's folly, Melvin cited the practice of putting nitrate-treated water back in the river; the filtering abilities of soil and sand; the rarity of blue babies; prairie and Iowa State research; and Iowa law into weakening any possible connections made by the lawsuit between drainage tile and water pollution. He positioned the utility and Bill Stowe as no more environmentally conscious than they required of farmers as well as ignorant and foolish around legal issues, specifically the standards for drinking water and state law. My exchange with Melvin was one of the most thorough deterritorializing efforts I experienced.

While Melvin was more thorough in his critique of DMWW, Lucille's earlier discussion represents a common pattern. Many corn assemblage actors questioned why these three counties had been singled out, arguing they were poor, agricultural and rural, and without much political power. Their distance from Des Moines and lack of relationship with the city also made them a target. Everyone told me, with frustration and affront, about the utility dumping nitrate-treated water back into the river. This mirrored

the dumping of tile water into creeks and rivers, but as Lucille stated, many corn assemblage actors also questioned the validity of nitrate originating and being transported from farms.

Caleb, a young beginning farmer in the Middle Cedar watershed, paused before answering my question about the lawsuit. Then, he said,

I think there's a lot more going on than what is perceived by the lawsuit. It has a water treatment plant that is outsized and outdated. This is a way to fund that. Bring emotion to it. I don't think there's anything to it. A grab at political fame for a person. I think it's crazy. I don't think it really has any kind of scientific facts. Pulling nitrates out for a lot of years. Why is it an issue now?...Why those counties? The county to the north - why aren't they sued? What's going on? I think it will go away. I don't think it will make it to courts. It's a scare tactic. How do you sue who are you suing?

Bri: Drainage districts?

Caleb: Which are government? Private? Government entity suing another - not farmers right?

[Bri tries to explain]

Caleb: I haven't invested much time. A government entity suing another. Seems weird.

Bri: DMWW is private now I think.

Caleb: It's a private organization, but they sell it to the public. I've seen facts and figures come out. They could fund a new facility. Cedar Rapids has been actively involved, working together. We don't necessarily have a problem. They are very active in our [watershed] project. There again you're trying to control the uncontrollable.

Caleb's account brought up several actors (e.g. the water treatment facility, drainage districts, Cedar Rapids) central to the corn assemblage's critique of the lawsuit. Bill Stowe in particular became a figure of ridicule in the corn assemblage. People questioned his motives and saw them as maneuvers to win political favor and appointment by groups like the EPA. They positioned him as a coward, environmental and even anti-farm activist, and self-promoter (all equally reproachful by corn assemblage standards). Others said, with questionable charity, Stowe thought he was doing what was right, and they could not blame him for trying to achieve his goals (e.g. EPA appointment, funds for a

new nitrate removal plant). Melvin loaned me an article on Bill Stowe in a glossy Iowa magazine, the CEO's portrait stark against a black background. There was a certain fascination around Stowe as a megalomaniac within the corn assemblage.

Caleb also brought up the issue of science and emotions. Within the corn assemblage, DMWW was not doing science. The claims about tile were not worth discussing because of Bill Stowe's motives and the water utility's own questionable practices. It was all political, and therefore emotional, not scientific, and this claim was an ultimate deterritorializing strategy. The collection of water as well as the transport of nitrates was suspect, although the analysis of the water samples could not be since they were sent to the Iowa Soybean Association, much to the producer association's consternation. The introduction of politics to the lawsuit erased any claims for scientific veracity from a corn assemblage perspective. This same political context was not considered for the NRS, a scientific and political document that meant to show Iowa's efforts to the Mississippi River/Gulf of Mexico Hypoxia Taskforce, and put forth the culturally acceptable voluntary and flexible approach to environmental conservation.

Farmers were not the only ones involved in the critiques I associated with the corn assemblage. Conservation experts who worked with farmers directly and were from the areas being sued echoed many of the conversations I had with others acting within corn assemblage. Agnes, a conservation expert in the North Raccoon area, told me,

There's more nitrogen leaving the alfalfa than leaving the corn beans. So how frustrating is that. Supposedly city people overapply their lawns. Well, that's something we can't control as a farmer. But you hope it's not true. Maybe it is. Maybe it's not. There's things like that, that we have no control. There's nothing wrong with alfalfa. Technically alfalfa should be better than corn or beans so it's frustrating then that people thought we weren't doing our job.

Agnes implicated alfalfa fields and lawns in her enrollment of vital actors causing the

problems central to the lawsuit. Similarly, Darren, another conservation expert in the North Raccoon area, stated that “Normal prairie loses eleven, twelve, fifteen parts per million. That’s unplowed prairie.” The logic of corn assemblage flattened and equalized the landscape to include lawns and golf courses as well as agricultural and prairie ecologies as responsible for nitrate pollution. This call for accountability—“we are all in this together”—spanned the realm of Mother Nature to cities and suburbs. This equivocation of landscapes minimized that most of Iowa is for agricultural use, as well as dismissing one of the key differences in lawn versus agricultural landscapes, that of ground cover (see Chapter 5).

These examples all demonstrated the way critique fit into the corn assemblage as part of the deterritorializing of the DMWW lawsuit. Corn assemblage actors cited other landscapes as equal to corn and soybean agriculture’s relationship to environmental problems. They dismissed any scientific validity of the lawsuit, rather emphasizing the politics of Bill Stowe and the utility itself. Since science had the only legitimate claim to determining Iowan landscapes, emotions rarely gained purchase as a legitimate territorializing mechanism, and when they were aligned with politics, they lost any ability to be publicly cited and supported. This public denouncement happened despite the roles that nostalgia, pride, anger, grief, and studied detachment had in organizing the assemblages, not to mention the ways politics in social and institutional relationships shape Iowa’s landscape. This drawing in of other landscapes and pushing out of science all fit into the overarching desire for continuity, since actors in the corn assemblage feared the consequences of regulation resulting from the lawsuit that would impede farm success and longevity.

The prairie assemblage demonstrated more ambivalence about the lawsuit. Several people I considered prairie actors found it was a legitimate claim and worthy pursuit. They believed that if the lawsuit became part of the infrastructure, this would overall be a good thing. So a few prairie assemblage actors reterritorialized the lawsuit. Starla, a Conservation County Board member and amateur naturalist said,

I think it was very much needed. It has brought the issue to the forefront...I'm all for it. I'm not a fan of lawsuits, but sometimes you just gotta do what you gotta do. I don't blame DMWW.

Similarly, Byron, another Conservation County Board member,

If you're in a public meeting with rural and urban, farmers [say] by God you shouldn't be suing us. We're feeding America. I hear that quote a lot. It's frustrating because half the soybeans go to China, half the corn goes into ethanol. I want to ask, so I get my carrots from you, apples, lettuce, peaches and plums, pears. They don't do it. They're into commodity crops. So I struggle with that piece. So you have the them versus us. "It ain't our fault." I've heard the statement, why do they draw the water from the Des Moines River? Why can't they take it from a well? It's natural you just have nitrogen. Seven percent is from natural causes. You've got the denial piece.

Byron highlighted several strategies utilized by various actors in the corn assemblage, such as moral hierarchy (feeding the world over land stewardship), equivocation, and denial. He also indicated another version of the ambiguous divide, farmers articulating an "us versus them" mentality. Then he compared Cedar Rapids and Des Moines, suggesting they were on similar trajectories in terms of nitrate pollution.

We should be working together [like] Cedar Rapids [who] has not hit critical tipping point. They don't have to have denitrifying [equipment]. They're [Cedar Rapids] worried. Des Moines is way past that, to keep governor's water safe. Groundwater and river has high numbers. Citizens of Des Moines are subsidizing the river. Bill Stowe has forced the discussion out of the box, out on table...It's forcing a dialogue. I don't think he wants Sac County to pony up for the next denitrification plant. He wants to start helping with the problem...

Byron then engaged in a hypothetical fantasy, where Gulf coast residents show the

legitimacy of the lawsuit by suing Iowa as a whole themselves.

If it isn't Des Moines suing, what are we going to do when Louisiana sues us when the Gulf coast state people - you've ruined our fishing environment. They sue, and we go to the Supreme Court. Bill pushed it. Governor is even talking about it, though he says it's a bad thing, even though it's his drinking water. The governor even made a fund even though he's stealing from education.

Byron summoned multiple actors and places—again the water plant, Des Moines and the sued counties, food, corn and soybeans, ethanol and China, the Gulf coast—and divvies them up into an ambiguous division of “us versus them.” He dismissed the strategies of the corn assemblage of implicating vital technologies and entities—the guilty utility and Mother Nature—by first enlisting a list of fruits and vegetables in contrast to China-bound soybeans and ethanol-bound corn. He then returned from China to Iowan urban centers pitted against each other in terms of regulatory (Des Moines) and voluntary (Cedar Rapids) approaches then down to Louisiana, where dead fish and Gulf coast people step into DMWW’s place.

Several people mentioned to me that DMWW had tried to address the problem before and that the utility stated publically they would be suing if nothing were done, at least two years before the lawsuit was announced officially. One farmer told me DMWW had been part of a North Raccoon watershed project nearly a decade ago, but after initialing agreeing, farm groups blocked its progression. When people acted as if they had never heard of the problem, several prairie assemblage actors called “bullshit, bullshit, bullshit.” This history gave DMWW some more credibility and reterritorializing power within the prairie assemblage because stories were circulated about their past attempts to both warn and collaborate had failed.

However, the strongest support of the lawsuit within the prairie assemblage came

from those not working directly with farmers. While people who worked with farmers did not deny the validity of the lawsuit, they did dislike the consequences of it. Some felt it had likely increased attention and visibility of the issue, putting water pollution to the center of both assemblages. The desire for continuity was contingent on cleaning water, just as the liveliness of the landscape could be achieved through the needs of this (re)source of life. The lawsuit had also created even more division, so while the water drew the assemblages into the same spaces, actors in each assemblage regarded each other with suspicion and trepidation, and the gulf between the desires seemed at once closer and farther apart.

4.3 Regulation

The biggest issue that emerged from the pitting of the NRS against the lawsuit was the question of regulatory conservation compliance. Potential regulation was the main focus of territorializing efforts. The corn assemblage was positioned against regulation since corn actors believed it would affect the continuity of farming. The type of regulation imagined was a one-size fits all approach, like the fertilizer application cap in the Chesapeake Bay. Often I asked if an approach like a water quality plan where farmers picked several practices from the NRS would be a more flexible and acceptable regulation. This idea mollified some people while others returned to governmental incompetence, suggesting that nothing sensible could come out of the federal level. They imagined the federal level as confined to D.C., divorced for agricultural realities. If they could not be sensible about the Chesapeake Bay, close enough to consult local farmers, then they could not be sensible about the more distant Iowa.

Earlier in my fieldwork, a farmer had told me he thought regulation could make it fairer, that it would not be a handful of farmers taking on the burden of risk and

experimentation when it came to conservation practices. This denaturalized the position of the early adopter, low-hanging fruit, conservation-minded farmer as overall being more inclined to try these different practices. I soon found that conservation could be undertaken as preparation for impending regulation, finding a new market niche, as well as more commonly cited reasons like generational conservation histories or psychological singularities. These contexts proved crucial in understanding intracultural diversity among farmers. This fairness perspective so fascinated me in its encouragement of regulatory infrastructure that I incorporated it into my interviews. Generally, actors in the corn assemblage dismissed this potential fairness. They could not imagine regulation from the government resulting in anything fair or sensible. When I asked Reese, a farmer in the North Raccoon watershed, he echoed Byron's earlier comment by saying,

What shapes my thoughts on that. Take those same farmers to a third world country. Let them see some of the starvation, the very poor diets the kids are subject to. Then ask them the question, "Do you think we should limit our production by reducing our nutrients?" It's just obvious to me. We need to produce more food. The good thing is we are doing that the last forty to fifty years, poverty rates throughout the world have decreased. We are making progress, a step backward if we don't continue along this.

He summoned the Third World, famine, and malnutrition to be saved by heroic corn and soybeans, justifying their place on the landscape. This evasion characterized another aspect of the corn assemblage. Actors rarely confronted tile as a point source, and similarly they would not consider a world in which regulation could be a good thing. I also would ask, since farmers received cost-share derived from taxes whether that should include accountability through a mechanism like conservation compliance. Actors in the corn assemblage saw this as untrue because agriculture did have a heavy tax burden in their view (eliding agricultural exceptions for property tax, fuel taxes, etc.) or that

agriculture should not take money from the government, although most farmers did, at least in the form of crop insurance. The corn assemblage was positioned against the federal government on most counts because actors saw continuity of the farm achieved through efficiency, a quality they did not grant to D.C. However, they also operated based on the heroism of the farm in providing necessities, worthy of national support. This left many actors, with more conservative politics especially, caught between ideologically accepting or rejecting subsidies, although most farmers accepted them. They did not question the infrastructure necessary to undertake industrial farming, which made it so risky in terms of capital investment and debt accumulation, or the political strategies advocating for this infrastructure. Instead setting it was understood as a seemingly natural, inevitable context.

Overall, the prairie assemblage was also positioned against regulation, particularly in the case of conservation experts who worked in compliance and did not see how to enforce regulation. They were concerned less with the effects on farming and more with its potential efficacy. Austin, a conservation expert in the Middle Cedar watershed, said,

I don't know if we want to legislate this water quality [issue]. Got to figure out a way to work together. A lot of people say Cedar Rapids is the best way to do it. Negative side is if someone comes out with these regulations, who will enforce them?

Again, as someone who worked with farmers and with an agency that could possibly be tasked with enforcement, Austin navigated the question of regulation with ambivalence, although he also expressed that financial incentives would not be the solution, unless there were no requirements attached. Neither regulatory nor voluntary compliance helped the prairie assemblage territorialize the Iowa landscape. This position was not unique to

those actors working in conservation. Clint, the farmer critiquing the NRS earlier, said this in regards to the efficacy of regulation,

So there's regulations right now that are in place that say you have to have a farm plan on HEL (Highly Erodible Land), [a] framework of what is allowed and not allowed. It is a joke. It is a joke.

Clint provided me with evidence:

Straight south of us a mile, a farm changed hands. There's an area of that farm hasn't been farmed in 40 years. New owner just chisel plowed it. It's really steep. There was no penalty. Nobody called the man...[Another piece] Hadn't been farmed in over 50 years...They plowed it up, and pushed out terraces. I didn't turn the new owners in - a neighbor did. Nobody knows what happened - [it'd be an] invasion of his privacy.

In the next section, Clint fantasized about a version of regulation exhibiting extreme social control, under his hypothetical royal decree.

I told NRCS, "If you commit a felony, you put it in the paper." If I were king and ran the program, you violated these rules. Since you're a slow learner - we'll give you time to learn the lesson. Rent it or farm it yourself - no farm program, no crop insurance, no cost share - that sanction stays with that land...New piece of ground? Same sanction applies. Corporation? Sure. Rules are not enforced. Tiger's got no teeth.

Clint's regulation fantasy used shame and punitive measures to protect land from exploitation, one of the more extreme proposals I heard. He also drew in neighbors, who may be "bad apples" or the protectors of the landscape. Bad apples were minimized to a handful of farmers but implicated as the main contributors to pollution because of a lack of care. Continuity of the farm and the liveliness of the land joined in condemnation of the bad apples because with soil losing fertility and substance, neither the land nor farm would survive. What corn assemblage actors rarely addressed was that good intentions did not prevent certain practices from causing environmental problem. Tillage destroyed soil, and bare ground created nitrate pollution in the water. This kind of science that laid

out basic ecological facts was often ignored or contested (see Chapter 5), since economic imperatives overpowered science in the face of yield and production. Corn assemblage actors organized skeptically around the science of conservation practices since economic and sociocultural factors were often secondary in this research. While some denied the connection between farming and environment, others denied that the cost to the environment was greater than the value of ever-increasing and expanding corn and bean production (Comito et al. 2012 and 2013a). Farm continuity trumped all.

Similarly, those being protective eyes for the land showed what many in the corn assemblage and even prairie assemblage lamented, the loss of the social fabric holding farming communities together. Group ostracism and shaming did not have the same social effects, and political infrastructure had “no teeth.” People even doubted the ability of neighbors to speak since turning someone in for conservation compliance damaged relationships, and in small communities, this had uncomfortable effects.

Nathan, who also dismissed the efficacy of the NRS, made these distinctions about regulation.

[You need to] distinguish between soft and hard regulation. Soft regulation creates incentives. Hard regulation are more like NRCS, what a government typically does. We're going to tell you how to do everything. They're [farmers] convinced NRCS and government will screw it up, and they probably will in fairness. Government could give tax breaks to breweries for barley incentives...People get a premium for how clean their practices are, same way carbon markets are talking about.

While Clint fantasized about hard regulation, a return of nostalgia for the power of the neighbor's opinion, concretized in infrastructure, Nathan considered the power of creating premiums and tax infrastructure that could support conservation practices. This kind of solution (rather than totalitarian fantasies) came up more often during my

fieldwork, including the ISA president stating land values should have conservation measures attached to them, not just CSR (Corn Suitability Rating) (see Chapter 6). It was radical reterritorializing fantasy in its own way. Value of the land typically could get reduced to corn yield, as CSR's determination in land values attests. However, tying land values to particular liveliness-promoting practices and results could tie human activity to ecological processes in an unprecedented way (see Chapter 7).

4.4 Working Without Consensus and Assemblage Bridging

On an evening in May, I went with Starla to a county conservation board meeting. I introduced myself and listened to the meeting proceedings in silence. After the meeting had finished, Saul—board member and farmer—leaned over to tell me with pride about his son-in-law doing strip till on a farm near Starla's parents' house. He continued that the selection of these counties was all political. The hope of DMWW was to get all of these 28 counties involved in the lawsuit, including Polk (where Des Moines is located). Saul also mentioned that there were more nitrates down in Polk County because of the lawns, concrete, and farmland, that the nitrates in Sac County had dissipated by the time it got to Des Moines and Polk County. The Raccoon River was cleaner than the Des Moines River watershed. It was all for political reasons. And why hadn't DMWW built a well like most water utilities? he asked.

He then echoed a statement that Melvin had told me, that they measured nitrates coming off a native grassland, and it had high nitrates. This was before settlement. An Iowa State study.

Starla replied, "Oh, I doubt that."

Saul told Starla to contact a well-known researcher at Iowa State. "You know him. He did the study."

Starla responded, well, if there was tile, that made sense. Tile bypassed the root zone where the plants would be able to take it up. It was all about losing the filter. Starla glossed over what Saul said, trying to move discussion away from Des Moines Water Works and focus on what needed to be done. She said, the legislature needed to pass code, and she cited research about how to filter water from tile. Starla reiterated that this was complicated.

As Starla and I stood in the small parking lot, listening to birds, she mentioned that Saul was quoting all Farm Bureau party lines but that some things surprised her, or that it was interesting to see how he was looking at it. Saul had told Starla's mom at one point in confidence she was right about the hog confinements being bad ideas. Although this vignette was not about desires within the corn or the prairie assemblage (farm continuity and landscape change were minor players), the interactions between Saul and Starla showed me the type of work that could happen around a boundary object. There was not consensus between Saul and Starla about what was best or desirable for landscape. Yet Starla discussed a private moment of concession between Saul and her mom about hog confinements. And I knew Starla and Saul would attend the meeting again next time to work together for the good of conservation within the county.

Although considering the discourse of these critiques helped me envision the construction of these two assemblages, actors could be in both the prairie assemblage and the corn assemblage. This bridging of the assemblages could occur in a number of ways; collaboration, competition, and hierarchy were all ways to mediate between the two assemblages and reterritorialize a vision of lively landscape, full of prospering farms and ecologies.

While tile was a companion technology that helped farm continuity, cover crops as companion technology could help farm continuity and land revitalization, depending on their liveliness as well as the material and ideological infrastructure supporting them, an example of collaborative bridging. Therefore, this bridging occurred when an actor of an assemblage tried to bring local forms of the conservation boundary object together, addressing both the continuity of the farm and revitalization of landscape. They still used the strategies I have discussed: critique, identification of absent and weak infrastructure, equivocation, and obfuscation. This tacking back-and-forth between the conservation boundary objects involved fantasies about viable alternatives, holding space for contradictory beliefs, as well as moments of reflexivity.

Maya, a tall and striking conservation expert with an easy chuckle, spoke to me about the conflict between her organization and her own values. Like many farm groups, her organization advocated for a voluntary approach, while she believed regulation could create the change that excited her.

Personally I look at, I own this portion of land. I own my house and my waste system. Every time I flush this toilet I have to pay for that. What's leaving my yard, I have to pay for. And I have to make sure that system is down the road to take care of it. I can't just be dumping it out by the back door. So I kind of parallel it to that. I think they should be accountable to what's happening, what's coming through their tile.

Here, tile became parallel to septic systems and the regulations surrounding sewage.

Maya also had a civilization level critique of the whole farming system in Iowa: “We are losing it [soil], and we are depleting it, and it's the basis for civilization.”

However, since her job was to work with farmers to implement conservation practices, she also described how she “met them where they’re at.”

I had come as an activist kind of person, disconnecting the humanness to the issue, so maybe my transformation came when I realized these are families that are tied to these issues. Lifestyle, their incomes, their families are supported by this. Really just meet them where they're at, and be part of moving them forward is how I took it. I mean initially I heard a lot more of the ag side, so initially I would get upset about it. But it's a century plus of practices that have been built to this point. And you're not gonna change that overnight. And again just meeting them where they're at has helped me a lot and not looking at it judging this is utopia but where we can go from here, next steps.

Through her experiences, Maya brought the concept of family, a meaningful organizing concept for her as a mother, into alliance with the problematization of tile and soil degrading practices. Similarly, Nathan echoed Maya by describing an “obligation culturally to take care of this whole environment. These amazing soils, they're really unique the world over. We have as much an obligation to our fellow human beings, people in the Gulf of Mexico and down river. This whole lawsuit at Des Moines Water Works,□they have to deal with that...[it's] a battle we lose in millimeters in a thousand different places. Water is an important precious resource we are basically ruining.” When I asked if he got caught in questions about yield versus environmental effects, he replied,

I probably just block it out. I'm as much of a crop nerd as anybody. You get busy and caught up in stuff. Work doesn't encompass all of your philosophical standpoints. None of us are lucky enough to be that pure...honestly, some of that stuff I evaluate from a strictly research based perspective.

Similar to Maya, Nathan did not approve of DMMW's approach:

I don't think farmers are the enemies here. Anybody in urban areas thinks that farmers are the enemy, it's unfortunate...farmers are just bit players in the system. Even the truly bad actors, they don't recognize how they impact. If we had wise political leaders...that's a tragedy of the American [dream]. [It's] inverted totalitarianism. We are all captives to our political economic system that's sort of serving itself more than anything.

Bringing in family and powerful societal structures, conservation experts working

directly with farmers could find peace in doing what they could to change the system. They recognized that while farmers' practices were the most immediate cause of pollution in this scenario, they also saw the corporate agribusiness system that supported and desired capital- and input-dependent monoculture agriculture for its own purposes. Maya and Nathan bridged corn and prairie assemblages with their physical and ideological labor.

Similarly, people I would have considered actors within the corn assemblage—based on their critique of DMWW—displayed perspectives that muddled and invalidated that distinction. But first, an experience that showed me I could not predict people's alignments, specifically that farmers only or mainly work as part of the corn assemblage.

Robert, an older livestock and grain farmer in southern Iowa, surprised me when he vehemently declared that he thought Bill Stowe was right, that farmers were the cause of pollution and they could not be. He grounded this in a lack of soil ethic, which could prevent this. He did not absolve himself, mentioning the gullies on his hilly land that came after heavy rains despite his collaboration with both no till and cover crops. But he believed deeply in treating soil as a resource, and not just in terms of acres, yield, bushels, and profit. He recognized the material limitations of a soil ethic but sought ways to bridge farming and environmental desires on the landscape. Robert's perspective could be traced back to several aspects discussed in Chapter 3. He owned the majority of his land. He lived in a part of Iowa where the soil was not as fertile as other parts of the state, which meant he raised livestock on pasture. Ownership, his ecological landscape, and his diversification strategies all supported his perspective on the lawsuit.

Matthew, a pensive older man, seemed like many of the farmers I had met. He

was unconvinced of the necessity of the lawsuit or even natural resource conservation. He did not see Iowa as exceptionally different from the rest of the world in terms of water pollution. Yet his reflexivity startled me at different points during the interview. When I asked about regulation and participation in the NRS, he said,

Naturally, I don't want anybody telling me how to do things. I don't like regulations. [laughing] I wouldn't be very happy. So that would be the last thing I'd want to do. And yet I'm not sure I'm ready to do some of these other things voluntarily. [laughing]
I don't know how you change my mind. I thought about that a lot. How would you change my mind so that I would be a full-fledged cooperator and do it voluntarily? And I don't know what would change my mind other than a scare.

His wife Virginia had been quietly attentive for much of the interview, and after this, she said, “We do not agree.” She revealed she was an environmental science teacher, and I lamented her silence throughout. This relationship gave insight into the path of Matthew’s reflection on the limited potential of the NRS as well as his own mindset.

Casey, a serious-faced farmer in his 30s, had found a landlord who required conservation practices like no till and cover crops. In response to regulations and the lawsuit, he said,

Casey: I don't think it's that big of a deal. They can't make us dig up our tile. Moving to spring application might happen...It's not that I don't care about regulation. I'm already doing everything I can. All I have to do is keep doing what I am doing...I'll be the one putting on meetings not going...I'll be ready.

Bri: No one has said that really. □

Casey: I don't want anyone telling me what to do either, but I can do it. I'm pretty pragmatic.

In both assemblages, people referenced that young and beginning farmers could change the course of agriculture since they were more willing to experiment with conservation. Similar to my farmer arguing for the leveling mechanism of regulation, farmers like Casey had taken that principle to heart and made conservation practices work in their

operations. He pushed the specter of regulation out of the assemblage by adhering to particular conservation practices—these practices were a reterritorializing strategy for the continuity of the farm, and by extension the landscape. This seemed to me a moment of hierarchy, where rather than yield, Casey prioritized innovation from a conservation practice perspective. He had the support of a landlord who wanted his land to be farmed this way as well, which gave Casey the opportunity to cultivate a competitive edge over farmers who were not experimenting and becoming familiar with these practices.

These moments all showed to me examples of bridging, whether it was putting personal convictions aside in order to do what work was possible like Nathan and Maya, or recognizing the limitations of current infrastructure despite it going against your best interests like Matthew and Clint, or already arriving to the future of the conservation boundary object, like Casey and Robert. Territorializing strategies had dual or multiple effects (i.e. conservation practices as farm continuity), as well as uncertain and wavering consequences (i.e. “meeting people where they’re at”). Bridging resulted in active participation in both the prairie and corn assemblages, and the back and forth movement did create space for the main desire of each assemblage to break some alliances and tentatively construct others. Lively landscapes can emerge from desires to prevent regulation that could constrain the continuity of the farm.

4.5 Concluding Remarks

Corn and prairie assemblage actors enrolled different nonhuman actors, technologies, and vital entities in building their assemblage to achieve their desires and push the conservation boundary object toward their respective desires. They silenced, obscured, and elided some, like corn assemblage members did in the case of tile. They highlighted the gaps in others, like many prairie assemblage actors’ assessment of the

NRS's gapping infrastructure (i.e. lack of sustainable funding and measurable goals). They equivocated (i.e. urban lawns are the same as farm fields) and they highlighted (DMWW dumps nitrates back into the river). I argue that this was not simply a matter of discourse but a material practice embedded in daily and institutional politics as well, methods of re/deterritorializing. If a conservation expert working with farmers went to a field day advocating for prairie strips and believed that prairie was just as likely to lose nitrates as corn and soybeans, the practice of planting prairie lost reterritorializing potential to be on the landscape materially through ideological and discursive practices. Analyzing how assemblage actors arranged themselves, and other nonhuman actors in relationship to each other and themselves, revealed consequences and trajectories of the assemblage.

The science behind the NRS focused solely on whether and how the conservation practice worked ecologically. Although the NRS did have economic analyses, when I spoke to people about the NRS, our conversation focused on the practices' ability to provide ecological benefits. Whether these practices were socially and culturally acceptable, and whether these practices were economically viable were both considered of secondary importance in the science. This left the work of economic and sociocultural values to other institutions and individuals around the state. This kind of strategy was not uncommon. Many development projects rarely have considered the full impact of their improvement or aid programs. Nevertheless, the NRS was the real, shared infrastructure of the conservation boundary object. It was state sanctioned, was contributing to grants, and had cultural salience for many farmers, farm groups, and conservation groups.

The corn assemblage reterritorialized with the NRS as it was. By supporting the

NRS, the corn assemblage could broadly claim conservation, using discourse appealing to the prairie assemblage's desires, but with practices that suited individual farming operations rather than resulting in significant improvements for the landscape. This was a weak bridging of the assemblage desires, one the prairie assemblage did not find adequate. The NRS had built in flexibility since the practices were not ranked, but rather available as options. Utilizing the NRS could be navigated without requirements for changes in land management, but still did serve the requirements to keep working with the prairie assemblage on the conservation boundary object. The corn assemblage did not feel threatened in their farm continuity desire due to the NRS, so the assemblage in general accepted this kind of flexible, weak, and locally grounded conservation work.

The prairie assemblage collectively deterritorialized the NRS by questioning its isolation from infrastructure giving it any chance of sustained success. They filled in these gaps left by the NRS with calls for monitoring and measurement, sustainable funding, and prioritization in terms of time and methods. The NRS was a step toward the goals embedded in conservation boundary object; it had infrastructural elements of helping the prairie assemblage attain its desires. The watershed projects provided some knowledge and some temporary financial support. Yet the prairie assemblage dreamed of more. Overall, they limited the reterritorializing potential of the NRS with their critiques (a deterritorializing method). This was because they wanted stronger infrastructure for the conservation boundary object. Many times people would ask me, echoing the pensive farmer Matthew, what would make farmers change? More cost-share? A specific kind of practice? A scare? While the NRS could help the prairie assemblage achieve its local definitions of the conservation boundary objects through its recommendation of cover

crops, pasture and perennials, and restored wetlands that slowed and made lively the landscape, there were too many other options that would have narrow effects without impacts for the landscape as a whole.

The lawsuit was a deterritorializing endeavor for the corn assemblage. By trying to the limit the legitimacy of the lawsuit's claims, this movement pushed corn assemblage actors to organize around the importance of the NRS and its attendant efforts. Actors ignored the question of tile as point sources, countering with the intentions and behavior of the DMWW CEO and utility as a whole. The infrastructure of tile allowed the corn assemblage to support their farm continuity desire, and they imagined, the livelihoods of others. Tile was enrolled into their desire of continuity, and thus in sacred ground. Occasionally, they summoned science and geography into this debate, to equivocate their practices with nature (which I cover in the next chapter) and urban areas. In contrast, the prairie assemblage, despite its desire for change, reterritorialized and deterritorialized by turns around the lawsuit. The lawsuit undermined the work of those bridging desires and work for farm and landscape conservation. As they saw failure in the NRS, here too they saw failure in regulation producing the necessary change (Roberts and Light 1991). For those without occupational connections to farming, and perhaps only emotional connections, it was easier to believe the lawsuit could bring the change they so desired for landscape: liveliness.

What would the lawsuit have meant for the conservation boundary object? It was only hypotheticals, fantasies, and nightmares, but it still had an impact on public discourse and bringing some farmers on the fence into NRCS offices, looking to try something. Many people summoned the specter of the state at the federal level, clueless

bureaucrats unconnected to the particulars of Iowa and making sweeping, simplifying, and/or unachievable declarations for the landscape (see Li 2007; Mathews 2005 and 2008, and Scott 1998 for examples). The corn assemblage feared a fertilizer cap, such as the Chesapeake Bay had (see Chapter 5 for complications to this kind of solution). Many in the prairie assemblage feared regulation as well, that it would mean more bureaucracy (i.e. reports and documenting) and less time for conservation work that they valued (i.e. technical assistance and field days). Others advocated for regulations similar to Minnesota, which had stream buffer laws, or in the words of several environmental groups in Iowa, a basic standard of care (e.g. buffered streams and no manure on frozen ground). Still others recommended a water quality conservation plan, which would require every operation utilize several practices approved from the NRS to receive crop insurance, similar to the 1985 Farm Bill's rules for HEL ground. Clint and others saw these kinds of rules well-intentioned but ultimately unenforceable, while many thought this would be a way to create accountability, soft regulation like Nathan had discussed with me. Ultimately, I cannot say what the impact of regulation would have been on the conservation boundary object, but regulatory changes to the object's infrastructure would likely be met with as much ambivalence as met the NRS. Would regulation be able to achieve conservation goals, for either or both the farm and landscape revitalization?

Without the event of the lawsuit, I may have been unable to articulate the assemblages, seeing mainly nutrient reduction in the Gulf as a uniting goal. With the dismissal of the lawsuit today, I could not say what remains of these assemblages, as they were breaking apart even in my discussion here. Before the lawsuit, the NRS had little political power beyond the world of those working in conservation. Throughout my

fieldwork, I was told many farmers had not heard about NRS or really understood what it was. The lawsuit gave the NRS more reterritorializing power through amplifying its virtual capacity to fend off impending regulations in addition to reducing nutrient pollution in waterways. The NRS's alliance with voluntary compliance lent political and cultural power to it. The governor at the time, Terry Branstad, spoke against the lawsuit but in support of current nutrient reduction efforts. Producer associations— such as the Iowa Farm Bureau Federation, Iowa Soybean Association, and the Iowa Corn Growers Association—all supported a voluntary approach. The alliance of executive and legislative actors and farm group association actors with a voluntary approach meant the NRS became far more significant in the face of omens of regulation.

The lawsuit gained power by its appeal to the courts, which ostensibly are not as tied to the politics of the state executive or legislative branch. Still, producer associations and farm groups gave financial aid to the legal defense of the three drainage districts, and legislators did attempt to disband the DMWW Board of Directors. While the lawsuit did have some support, it was not generally from the people I worked with. Many of the people I worked with were conservation specialists who worked with farmers, with whom most of the conservation work was happening.

Yet gaps persisted. Clint strongly opposed the lawsuit yet dreamed up a harsh regulatory reality where accountability for bad practices tied farmers, land values, and farming together. Maya approved of both regulation and the education and outreach arising from the NRS. These gaps left room for the productivity of the assemblage to continue working on a vague but deeply desired conservation.

CHAPTER 5

MUDDYING THE WATER: THE CIRCULATION OF NITRATE KNOWLEDGE

Quisieron enterrarnos, pero se les olvidó que somos semillas.
They wanted to bury us, but they forgot that we are seeds.
- Mexican proverb

At the center of politics, scientific knowledge, and emotions in Iowa, nitrate traveled with and across the corn and prairie assemblages by way of its problematic movements with water. Materially, nitrate would go where other chemical compounds would not—bonded to water, past inquisitive sensors—and semiotically, it erased the significance of other pollutants due to its entangled alliance with the Des Moines Water Works lawsuit and, to a lesser extent, the dead zone.

At its most fundamental level, nitrate is one nitrogen atom surrounded by three oxygen atoms. This bond creates a chemical compound with an overall negative charge. Nitrate is part of the nitrogen cycle (see Figure 5.1 for example), and one of the chemical transformations of nitrogen as it circulates between the ecosystems in the air, water, and soil. Nitrogen-fixing soil bacteria and fungi transform nitrogen in the soil into ammonium (nitrogen surrounded by four hydrogen atoms, with an overall positive charge), which nitrifying bacteria transform into nitrites (nitrogen surrounded by two oxygen atoms, overall negative charge and less stable compound than nitrate) as well as nitrates. At this point, the fate of this nitrate has several pathways—released to the air, used by plants, or

move with water. Water—one hydrogen atom with two oxygen atoms in orbit—bonds with polarized compounds, as a bi-polarized compound itself, with shifting negative and positive energetic poles. Where water goes, the material and political consequences of nitrates go as well. Nitrates in source waters used by drinking water utilities had generated political consequences, so the question was, why were the nitrates getting into the water? Were farmers applications of nitrogen fertilizer adding too much nitrogen for the system to process? Was the nitrogen cycle in the soil inefficient or overabundant? Was there a missing link in the cycle to keep this nitrogen contained to the soil rather released into waterways? All of these questions focused on the “origins” of these problematic environmental nitrates, although there are no true origins in a cycle.

Nitrates entangled with other assemblage actors, entities, and technologies. Tile transported nitrates that had bonded to rain and water in the soil and ended up in the creeks, streams, and rivers. Cover crops tried to capture nitrates for their own purposes, provided the plants lived long enough to participate in the exchange between soil microbes, water, nitrates, and their own tenacious and tender root systems. DMWW tried to account for nitrates with their lawsuit that would legally transform nitrates’ subways—drainage tile—from an unregulated nonpoint source to a federally regulated point source. The NRS tried to capture, dilute, and reduce nitrates as well, but with its toolbox, before the nutrient-pollutants rush down the Mississippi River and into the Gulf, playing their destructive parts in dead zones and coastal erosion. Nitrates entered human bodies, constructing the uncertain figure of the blue baby as the health consequence that, in part, led to the 10 parts per million (ppm) standard set by the EPA. Nitrates were an unintended consequence of the drastic land changes in Iowa. They were nutrients,

essential and easily lost, indifferent to the common discourse of not wanting to lose them. They were water contaminants. They were uncertain vital actors in the well-being of human bodies and other ecologies.

In this part of story, the central questions about nitrates were these: Where do nitrates come from? What are the environmental origins of nitrates? These questions also entangled with the consequences of nitrates—specifically human and environmental health—and what could be done about their elevated presence. Corn and prairie assemblages oriented themselves and specified their internal relationships around this question. What each assemblage identified as the origins of environmental nitrates as well as their consequences affected how accessible the assemblage desires for farm continuity and for biological liveliness were. In other words, the narratives about nitrates changed infrastructure with the conservation boundary object, privileging particular ways of working over others.

To answer this origins question, I examine the various sites where nitrate knowledge circulated. Nitrate knowledge was (1) produced, (2) circulated, and (3) utilized. (1) It is produced in the lab, which for a land grant university like Iowa State often consists of agricultural test plots at extension and other research stations throughout the state. Nitrates are also tracked by sensory technologies, which multiple groups may utilize, including DMWW, ISA, the Iowa Flood Center, and citizen science projects like IOWATER, which I discuss in Chapter 6. (2) This knowledge was presented and circulated at conferences, put on by various stakeholders and their partnerships, at field days, and in mass media through print, speech, and visuals. (3) After these initial moments of circulation, various groups re-circulated this knowledge in order to do

ideological work and impact decision-making. Depending on the version of the narrative and generic²⁰ repackaging an individual or group utilized, nitrate origins redistributed blame and accountability to different actors, and could therefore influence behaviors and practices, increasing or decreasing feelings of responsibility.

In this chapter, my points of contact and discussion encompass parts 2 and 3, the circulation and utilization of nitrate knowledge using analyses of both media and ethnographic data. I review the “business as usual” reporting from four kinds of media on topics related to agriculture and conservation, specifically to whom and how these sources imagined they circulated knowledge. Then with the emergence of the DMWW lawsuit in early 2015, becoming official in March that year, nitrates as pollutants became publically politicized in an unprecedented way, which put them under intense scrutiny and speculation. This heightened attention provided the political context for circulation of nitrate knowledge. After examining nitrate’s circulation in the news, I introduce my bewildering first encounters with nitrate origins narratives at two conferences (out of the nine total I attended), other significant sites of circulation. Finally, I consider the uptake of this knowledge, and the implications of the uptake, among various research participants.

Drawing on studies of circulation (Briggs 2007a and 2007b; Lave 2011; Briggs and Mantini-Briggs 2016), I consider, what then made narratives from my fieldwork “immutable mobiles,” entextualized, communicable texts both widely or rarely circulated? How did this all relate to Iowa, and the tensions surrounding conservation as

²⁰ Generic as in “related to genre”

boundary object? How did these narratives deterritorialize and reterritorialize the infrastructure of conservation in the imagined court of public opinion?

Nitrates became part of the infrastructure of the conservation boundary object around which media as well as human and nonhuman actors organized (Star and Griesemer 1989; Star 2010). Debating the origins of environmental nitrates was the method by which the prairie and corn assemblages made local versions of the root cause of nitrate pollution in the water. Yet they still came together to do work for conservation.

In my research, science had symbolic authority (Briggs and Mantini-Briggs 2016). It was institutionalized as the legitimate form for producing and projecting. Many people used the phrase “science-based” when reflecting on necessary standards for policy (Kinchy 2012). This phrase was said with disgust when science was deemed lacking or pride when it was seen as the foundation (i.e. in the NRS). All other discursive genres tried to engage with scientific genres like technical reports and peer-reviewed journal articles. News articles, advocacy statements, policy documents, public presentations, and promotional materials all parsed science for their audiences/imagined publics. The ability of a source to successfully claim scientific symbolic authority simultaneously ratified or legitimized the author (Goffman 1981).

In terms of indexical and/or contextually co-occurring associations (Bowker and Star 1999; Briggs and Mantini-Briggs 2016), I identified three main contextual/pragmatic features of the structure of discourse in typical news-type media genres. Specifically, this included patterned and predictable ways of reporting scientific information. Through considering the processes of entextualization, I chart how the semiotic (i.e. meaning-

making) processes of creating a text make some parts of discourse seem to travel (i.e. some parts are more easily extractable from one event and reinserted in another).

First, the hierarchal and sequential organization of information was one significant feature across news-type media accounts, such as what was presented first and what ideas were connected to each other. Sequencing of information and people's perspectives could justify the separation of interconnected ideas as well as erasure of some parts to make a presumed whole. For example, which part of the nitrate origin research was presented first would frame the rest of what people read. Generally, the naturalness of the nitrogen cycle was presented before the absent plant roots, and in separate sentences, which allowed the plant roots to be erased, making the naturalness seem "immutable."

Another category was related to Goffman's participation framework (1981), specifically who was speaking, what granted them authority to speak, and how they were connected to ideas. How writers and speakers imagine their audience/the public is significant. Researchers, journalists, and conservation professionals try to anticipate what will be culturally salient and morally acceptable to their perceived audiences, typically the "agricultural community," the non-farming urban "community," or Iowans as a whole.

Finally, connecting these narratives to other widely circulated immutable mobiles—both symbolic and conventionalized expressions (e.g. Mother Nature, the dead zone) and iconic forms (e.g. photographs or diagrams depicting a particular region)—were also important to consider. Iconic signs, along with conventional, colloquial cultural expressions (e.g. Mother Nature), are often said to contain some sort of essential quality

or qualities that appear to truly reflect the object or concept denoted. Gregory Bateson (1979) long ago made the point, “the map is not the territory,” i.e. representation is not equal to the thing being represented. Nevertheless, despite people knowing the difference internally, maps and landscape photography are often treated as the thing denoted due to the intrinsic semiotic quality of iconicity. When used in news media accounts, icons become immutable mobiles, which are “forms that travel across geographies and genres without losing authority or shifting meaning” (Briggs 2007a).

The main iconicized news media representation of nitrates in this story is research from Iowa State University that claims that it is not fertilizer creating nitrate problems in waterways but human disruption of ecological relationships through the structure of the cropping system itself, in a phrase, the absence of plant roots. Two versions of this research circulated, however. Soil microbes were the perpetrators in one, often being subsumed within conventionalized tropes such as “Iowa’s fertile, black soil” and “Mother Nature,” both of which operated as immutable mobiles prior to the circulation of the nitrate origins narrative. The explicit relationship between soil microbial activity and absent crops, specifically erased roots, was the other version. Through their immateriality, absent plants roots had a material effect on the landscape, at the same time they had an effect on the circulation and uptake of scientific knowledge. Their immateriality was either acknowledged or erased, depending on the desires of the media sources circulating the information and people receiving the information.

Diverse stakeholders drew upon the symbolic authority of science—specifically agronomy, soil science, and broadly, environmental science—to make their truth claims. However, I argue that the communicable cartography and related processes of

entextualization through which nitrate origins were made to travel was categorically different from other political and emotional attempts to distribute blame and accountability. Scientific understanding has been manipulated in the past, broadly and within Iowa, with calls for “more evidence” for scientific theories and selective reading of research (Comito et al. 2011 and 2012). A parallel example to the one I discuss here is anthropological and social scientific insights into sociocultural interpretations of climate change science. Many of these studies demonstrate how people interpret climate change science within their own cultural and ideological frameworks, and how this contributes to diverging understandings of climates change (Barnes et al. 2013; Lahsen 2013; Rudiak-Gould 2013). How this nitrate origin science was used in this moment in my analysis is different from what Comito et al. (2011 and 2012) document. The lawsuit catalyzed the need to claim versions of nitrate origin narratives. Nitrate origins were of interest to the prairie and corn assemblages, because depending on the narrative version the assemblages promoted, it was fodder for either continuity or change advocacy. Denying nitrate origins from agricultural sources provided one less pressure—specifically and agricultural pollution origins and resulting environmental regulation—on farm continuity. Demonstrating nitrate origins were deeply embedded within the infrastructure of farming would give more credence to the necessity for landscape change.

To trace these communicable cartographies of nitrates, I analyzed articles from four sources—*The Des Moines Register* (from the state capital), *The Gazette* (from Cedar Rapids), *The Storm Lake Times* (located in Sac County, one of the sued counties), and the Iowa Farm Bureau Federation’s *Spokesman* (the state office located in West Des Moines)—and ethnographic data. In this section, I consider how each source imagined

their “publics” who were reading their stories, and the generic resources employed.

Within the articles, I sought instances where the research study about nitrate origins emerged and how the author or speaker operationalized it. Additionally, I use the idea of assemblage (i.e. a “news assemblage” to convey writer’s material summonings) separately from the prairie and the corn assemblage here to discuss how different writers arrange humans and nonhumans within their articles to convey their desires to and for their publics.

According to the Iowa Newspaper Association, *The Des Moines Register* has a readership base of 142,604. *The Gazette* has a readership of 85,212, and *The Storm Lake Times* has a base of 5,808. In 2015, the Iowa Farm Bureau Federation had about 160,000 members (Ballotopedia), although several people told me they had only joined for the insurance, which could indicate a smaller readership for the IFBF publication, *The Spokesman*. The United States Census Bureau estimated in 2017 that a little over 3,145,000 people lived in Iowa. I chose these sources because the newspapers represent regionally the two main watersheds (the North Raccoon and the Middle Cedar) where I worked as well as the cities pitted against each other in terms of the lawsuit and voluntary conservation approach (Des Moines and Cedar Rapids).

To consider the political context for each source, I do so mainly from the position of agriculture. It was necessary to discuss the resonance each source had specifically to agriculture because, as I have discussed, this industry provided the economic, ideological, political, and cultural foundations for the state. Questioning agriculture and farmers generally earned someone a label akin to “anti-farm activist,” just as Bill Stowe sometimes did. During my fieldwork in Iowa, *The Register* had a reputation for being

somewhat “anti-farm,” specifically since it was based out of the capital city of Des Moines, which many farmers and farm groups boycotted during the time of the lawsuit. *The Gazette*, located in Cedar Rapids, the “good” ag-urban collaborative city, gave that region as a whole more legitimacy. Whether this translated to *The Gazette*, though, I am not certain.

The Storm Lake Times had very little cultural capital among the farmers and farm groups with whom I spoke. I told Art Cullen, co-owner of and journalist for the newspaper, that some farmers suggested I speak to him, as he was on the “other side.” With surprise and some disappointment, he replied, “Really? Not the whole picture?” In 2017, *The Storm Lake Times*, specifically Art Cullen, won the Pulitzer Prize for “tenacious reporting, impressive expertise and engaging writing that successfully challenged powerful corporate agricultural interests in Iowa” (Pulitzer.Org 2017). *The Storm Lake Times* forced the revealing of private donations from farm groups like the Iowa Farm Bureau to the legal defense of the county drainage districts being sued by DMWW. In sum, none of these newspapers seemed to have much cultural salience with the farm groups and farmers with whom I worked.

The Spokesman is distinctly different from the other news sources. While the newspaper names are typical of the genre (*Times*, *Gazette*, *Register*) and speak to a tradition of informing the public about events, *The Spokesman*’s name metapragmatically signaled how the Iowa Farm Bureau positions itself as speaking for its members. This name, changed recently from *Capital Reflections* (Ballotopedia), indicated the political advocacy done through activities like lobbying and trips to different countries. According

to their website, *The Spokesman* is “Iowa’s leading agriculture news source and the largest circulation ag newspaper in Iowa” (Iowa Farm Bureau Federation 2018).

The Spokesman was not generally discussed as a source; however, many farmers expressed that the Farm Bureau represented their interests and advocated on their behalf in the state and national legislatures. I attended several Farm Bureau meetings where farmers reported on their lobbying²¹ efforts in D.C., for example, against GMO labeling and for the Trans-Pacific Partnership. *The Spokesman* did not position farmers as problematic or polluters, emphasizing conservation efforts and the difficulties of implementing them. It did not allow people to speak against (or what would be seen as such) farmers or farming within its articles. The way in which they circulated knowledge about nitrate origins, and the way it appeared during my fieldwork, showed me the great communicable cartographic reach of *The Spokesman*.

Within these four sources, nitrate co-occurs with several other contexts: the dead zone and the Gulf of Mexico, human health and the human body (blue baby syndrome and, more recently, cancer), conservation practices (i.e. cover crops, bioreactors, saturated buffers, restored wetlands); the DMWW lawsuit; and the naturally occurring nitrogen in the Iowa’s deep, black, rich, fertile soils. Several of these storylines already circulated as immutable mobiles themselves. The dead zone, blue baby syndrome, “black, fertile soil,” and Mother Nature all were tropes that had their own histories and poetic summoning. Both the dead zone and blue baby syndrome iconized to a certain degree suffocation and oxygen loss, with infants turning blue and an ocean full of dead fish. Blue baby syndrome was associated with the 10 ppm nitrate limit in drinking water, so

²¹ Lobbying was a primary activity of many of the groups I worked with in Iowa, not just agricultural groups.

the EPA and drinking water utilities like DMWW were most often associated with this image. The dead zone was the subject of the NRS. People would question existence of these issues and extent of their effect to me often since both crises were used for policy.

“Black, fertile soil” and Mother Nature were related but not the same. Mother Nature, in addition to the soil, also encompassed the weather, particularly extreme weather. Yet she could discursively be transformed into the soil, which made the conditions of the soil appear natural, despite the significant alterations to its ecology since colonial contact. The “black, fertile soil” of Iowa was also a trope commonly used. It summoned a 10,000-year-old glacier, which, through the work of prairie, made the soil “young.” One farmer told me a non-Iowan asked him once why farmers “burn the soil” because he had never seen any as black.

In all of these contexts, though, nitrate shared the characteristics of excess, loss, and need for reduction. Nitrate either showed up in overabundance or evaded the attempts to get rid of or lessen its presence. Nitrate occurred in all of these places naturally, water, soil, the human body, the Gulf of Mexico, but the combined effects of human-environmental interactions have caused more nitrate to be in circulation than is good for any of these systems: water utilities, people, rivers, oceans. Agricultural fields and soils were a more neutral zone for nitrates to exist since plants and microbes use nitrate for survival and growth, but even here, the production and loss of nitrate indicated declining fertility of one of the richest topsoils in the world. Everyone agreed that nitrate was necessary but not as much as Iowa is producing right now.

5.1 Nitrate Origin Story

The analysis of news sources occurred after my fieldwork. I wanted to contextualize and enrich my ethnographic data on nitrate knowledge. My advisor

encouraged me to consider different media sources and see how they had presented this knowledge. I had read the news and other media sources while I was in Iowa, but not so in-depth nor as consistently. It revealed to me a realm of circulation I had only been vaguely aware of, and how much the lawsuit had escalated the discourse surrounding nitrates. In what follows, I underline within quotations from articles to draw attention to and track the textual positioning of different human and nonhuman actors. In January and February 2018, I searched these various databases using keywords like “nitrate(s)” and “natural nitrate(s),” which generated roughly 200 articles. Out of 200 articles, I analyzed 54 which included discussions of the origins of nitrates.

On April 11, 2015, nitrate’s origin story changed. Before this, however, the nitrate origin debate oscillated between two poles: human activity/fertilizer and natural systems/weather. The following excerpts represent “business as usual” accounts. Journalists drew on the genre of unbiased news reporting, although they would embed their own perspectives. This, in part, counters the reporting from sources like *The Spokesman*, which, while using some aspects of the genre of balanced reporting, also drew on genres like political advocacy and promotional materials. So while within an article, *Times*, *Gazette*, and *Register* journalists would reveal their own perspectives, they were also providing an alternative perspective to a source like *The Spokesman* and the letters to the editor from *Spokesman* readers.

When considering how people read the news, headlines are often the first draw. Simply reading the headline may constitute a person’s knowledge of the news (Table

5.1).²² Orlan Love connected agricultural fertilizer with environmental degradation in the Mississippi and the Gulf. In Cullen’s headline, key actors were identified: DMWW; three rural, agricultural countries; rivers; and nitrates. It ordered these key actors in such a way that the lawsuit seems legitimized. There were no “claimed” or “supposed” adjectives qualifying “nitrates in rivers.” In Eller’s headline, her public would have to continue reading the article in order to determine the cause and the location of high nitrate levels.

Table 5.1 Exemplars of headlines drawing in/on their publics

Date	Source	Author	Headline
8/4/13	The Gazette	Orlan Love	“Farm fertilizer runoff wreaking havoc: ‘Nitrogen pulse’ impacting Mississippi River, worsening Gulf of Mexico's dead zone.”
11/11/13	The Spokesman	Dirck Steimel	“Reduction in river nitrate shows value of conservation”
12/4/14	The Des Moines Register	Donelle Eller	“Nitrate levels hit record highs in 2 D.M. rivers”
1/9/15	The Storm Lake Times	Tom Cullen	DM Water Works to sue BV, Calhoun, Sac counties over nitrates in rivers

Since this was the *Des Moines Register*, concentrating on rivers moving through Des Moines (“D.M. rivers”) was sensible but also suggested an upstream origin of the nitrates, as Iowans familiar with geography could intuit. In Steimel’s headline, farm conservation was linked to nitrate reduction, an ideologically acceptable position for many farmers and farm groups. Would these source’s different publics read on into the article out of anger and need to disprove? Or would they continue reading for validation? Curiosity and interest? Only my ethnographic data provided me with some evidence of the effect of the headlines. I present those findings below. But first I take a look at the

²² These were some of the oldest examples of nitrate origins in articles I could find online, which was why I presented them in this table.

structuring of several key texts for a more in-depth consideration of what readers of articles might have experienced.

Beyond Orlan Love's headline, the rest of the article reflected more ambivalence, with weather entering the assemblage—drought followed by torrential rains that washed away the unused nitrogen fertilizer. Love also cited a marine biologist, who drew in the pathetic attempts of aquatic animals trying to escape suffocation and the impact on shrimping industry. Love cited mothers and children at risk, "A large study of children in Iowa and Texas, published in late June, found that babies whose mothers consume nitrates in drinking water have a higher risk of spina bifida, cleft palate and other birth defects." He ended with pulling in an ineffective NRS, floating outside of time and measurements, and the impending threat on Cedar Rapids drinking water sources. Here the assemblage was far-ranging and in a precarious position of survival and well-being. Love drew on the authority of science from multiple angles, typically regionally specialized, Iowan and coastal ecological science and a public health in and out of Iowa. The central vital technological actor here, though, was fertilizer.

In Dirck Steimel's article, he discussed how nitrate levels were down in the Iowa and Illinois Rivers, drawing on the authority of the USGS (U.S. Geological Service). He used the nonspecific "previous studies" that demonstrate rainfall and temperature's impact on nitrate movement to waterways. This weather-related transport limited the efforts of farmers, he stated. Here the central vital entity actor was the weather, and Steimel also drew on science, with far less specificity than Orlan Love.

Donelle Eller reported in her December 2014 article on the nitrate levels in the rivers and different groups' responses to their origins:

Higher concentrations of nitrates are more common in the spring, when excessive rain washes unused fertilizer from farm fields into streams... Nitrates occur naturally in the soil but can spike in water when manure and other fertilizers drain off lawns and farm fields and into waterways... “Further, the persistent argument that ‘weather is to blame’ for this situation is wrong,” he [Bill Stowe] said. “Science proves weather and other natural conditions do not create excessive nitrate concentrations. Intensive land use and extensive agricultural drainage systems are the source of the high nitrate in our source waters.”

But the Iowa Farm Bureau said the weather did contribute to the high nutrient levels in state waterways...

“It is most likely that the wetter, milder temperatures this fall have contributed to the unusual movement of nitrates in the Raccoon and Des Moines rivers from a variety of sources,” he [Rick Robinson, IFB environmental policy advisor] said. “Most reports from agronomists and co-ops are that only 25-50 percent of planned fall fertilizer was applied.”

In this account, agricultural fertilizer was implicated as the primary vital technology in nitrate creation, although Eller included urban and natural origins as well. However, Bill Stowe, DMWW CEO, connected elevated nitrates and farming, citing science as his context. Immediately after, Rick Robinson, the IFBF environmental policy advisor, brought in the relationship between weather and elevated nitrates, which Stowe had already discredited in his statement. Stowe had the final word in this piece, where the DMWW enumerated the unprecedented levels of nitrates in two rivers, which was the main gist of the article’s title. While Eller’s inclusion of multiple origins suggested ambivalence, she subtly pointed to fertilizer, through sequencing, who cited science (Stowe rather than Robinson), and through her own omniscient phrasing (“...excessive rain washes unused fertilizer from farm fields into streams”).

Mere months before the official announcement of the lawsuit, Tom Cullen echoed Eller, using Stowe’s assertion that high nitrate levels were from farm fertilizer washed off during rains through drainage tile and systems. He quoted Rick Robinson and the Buena Vista County Supervisor who again pulled in the weather. The Supervisor brought in the

desire of farmers, saying they're not "anxious to spread fertilizer around and let it drain off...It doesn't make business sense."

"It's likely that the wetter, milder temperatures this fall have contributed to the unusual movement of nitrates in the Raccoon and Des Moines rivers from a variety of sources," Robinson wrote...

Stowe called Robinson's assertion "goofy" and "not square with reality."

Again Stowe had the last word, both here, and later when he questioned why we expected voluntary compliance for drinking water when we did not for taxes or traffic. Sequencing ratified Stowe as the most authoritative speaker.

For the three news sources, nitrates were entangled in the assemblage with fertilizer and drainage tile. *The Register* and *The Storm Lake Times* allowed both DMWW and the Farm Bureau to speak, but the conversations presented allowed Stowe to have the last word in both cases. Meanwhile, the Farm Bureau cited the weather. All of these sources utilized science, sometimes citing specific studies and researchers, but generalized references to science, data, and evidence also have symbolic authority. As is evident in the case study from my fieldwork, scientific research can easily become decontextualized from its origins, becoming an immutable mobile that circulated with the impression of holism and transparent truth (Latour 1987, 1988).

On April 11, 2015, *The Register* published an editorial by Drs. Michael Castellano and Matthew Helmers, an Iowa State agronomist and drainage expert respectively. In this editorial, they presented a shift in the assemblage where nitrate origins become both familiar and strange. Here I highlight several significant aspects of the research, internally and in the paragraph following this excerpt.

“Corn and soybean fields are the primary cause of nitrate in Iowa waterways...Most nitrate is lost from corn and soybean fields before they are planted and start to vigorously grow. During these times, if the soil is warm and wet, microbes naturally produce nitrate from the soil. Microbial nitrate production exceeds nitrate uptake by corn and soybeans in all but two or three months of the year. Without corn or soybeans to use it, nitrate is transported by rain from soil to waterways...”

In contrast to annual corn and soybeans, perennial crops, pastures and prairie lose very little nitrate. When soils are warm and wet, these perennial plants are using the nitrate produced by microbes.

Helmets and Castellano introduced human and ecological elements as the co-producers of nitrate loss, but not the formerly cited fertilizer or weather. Rather, the very foundation of contemporary Iowa agriculture—corn and soybean plants themselves—became implicated in environmental degradation through their annual natures and part-time labor in Iowa’s rich, black soil. Fertilizer rates could be reduced or capped, but the cropping system, according to this research, was the root cause of nitrate pollution, far more condemning than quantitative adjustments. This was systemic. These annual monocultures had disrupted the symbiotic relationship between perennial systems, soil microbes, and rain, creating gaps that result in loss and degradation. To echo the researchers, “corn and soybean fields are the primary cause of nitrate in Iowa waterways.” They also presented solutions: perennial crops, pasture, and prairie.

Their whole argument points to one vital loss in Iowa’s corn and soybean landscape—the absence of ready and waiting roots. Prairie always has roots present to wake up with soil microbes and exchange nutrients. Corn and soybean monocultures do not; harvest typically leaves the soil bare until spring planting, and the seeds cannot immediately utilize the amount of nitrate that soil microbes produce once they are planted in the ground. In the circulation of nitrate knowledge, it was important to notice if the media accounts included or erased these absent roots.

My bewildering encounter with the erasure of roots first occurred during my travels on the conference circuit. In Iowa, winter was conference season, spring was planting season, summer was field day season, and autumn was harvest season. Many of the farmers and conservation professionals I met spent much of their time gathering information in the summer and winter months. When there was not active work in the fields (different for farmers with livestock), I found them at these meetings. I attended nine conferences with various foci, politics, and stakeholders, with over half of them occurring between November and February. I felt information fatigue by the end of my circuit, a common emotion experienced among Iowan farmers, who were bombarded with information on various topics from multiple sources.

Yet the first time I heard of nitrate origins research, I was not fatigued but curious and attentive. I was at an Iowa Farmers Union conference, my first farm group conference, in November 2015, where I went on a DMWW tour and first saw in action farming tied to political advocacy. The Iowa Farmers Union is the oldest farm organization in Iowa, but it is seen as the somewhat of a redheaded stepchild. Progressive in their politics, members of the organization actively express both corn and prairie assemblage desires, since the organization desires that farming both changes and continues, i.e. adapts.

I was in a session titled “SPEAKING UP—MAKING CHANGE: Unraveling the Systems that Created Iowa’s Water Quality Dilemma” with three speakers slotted to speak. The first two speakers—women—made emotional appeals for collaboration and to the gift of water as life, joy, and inspiration, as well as citing focus group research and quantitative facts of waterway impairment.

A representative from IAWA (Iowa Agricultural Water Alliance—a farm association group) got up and suggested, “it’s time for science,” which incensed my neighbor but did not resonate with me much at the time. He discussed the hypoxic zone as both a reason to organize and a “big deal.”

The representative introduced the crowd of us to something called the natural nitrogen bank.²³ Ten thousand pounds of nitrogen were in Iowan soil, mostly locked away from plant use. Commercial fertilizer went onto the soil for corn; very little to none went on for soybeans. Then the mystery, I recognized later, was revealed: both corn and soybean fields lost about 30 pounds of nitrates. How could that be so when soybeans did not receive nitrogen fertilizer since it fixes its own nitrogen?²⁴ It was the soil, specifically soil microbes, converting nitrogen to nitrate. Nitrate, the water-soluble compound, was carried away by the rain that often falls in Iowa, heavier and heavier in the spring, and even the fall now. This natural nitrogen bank was the source of most of the nitrates, and it came from the soil, Mother Nature herself. Hypoxia, he said when returning to the topic of the Gulf, was a mostly naturally occurring process. So what could we expect farmers to do? This nitrate pollution Des Moines Water Works was suing over was not a farmer problem in essence. He repeated, hypoxia brought us here, and it was a big factor.

I stared at the graphic on the screen, trying to understand (Figure 5.1). How could the water utility sue the drainage districts, blaming farmers, if soil naturally lost nitrate? How could hypoxia be a big deal if microbes were the culprits due to their

²³ While I heard the natural nitrogen bank during my fieldwork consistently, in direct conversations people referred to it as “naturally occurring nitrates/nitrogen.”

²⁴ Soybeans “fix” their own high need for nitrogen by exchanging carbohydrates for atmospheric nitrogen converted by soil bacteria.

overproductive labor, not farmers? I walked away from the conference, a bit troubled, copying down this odd fact in my notes.

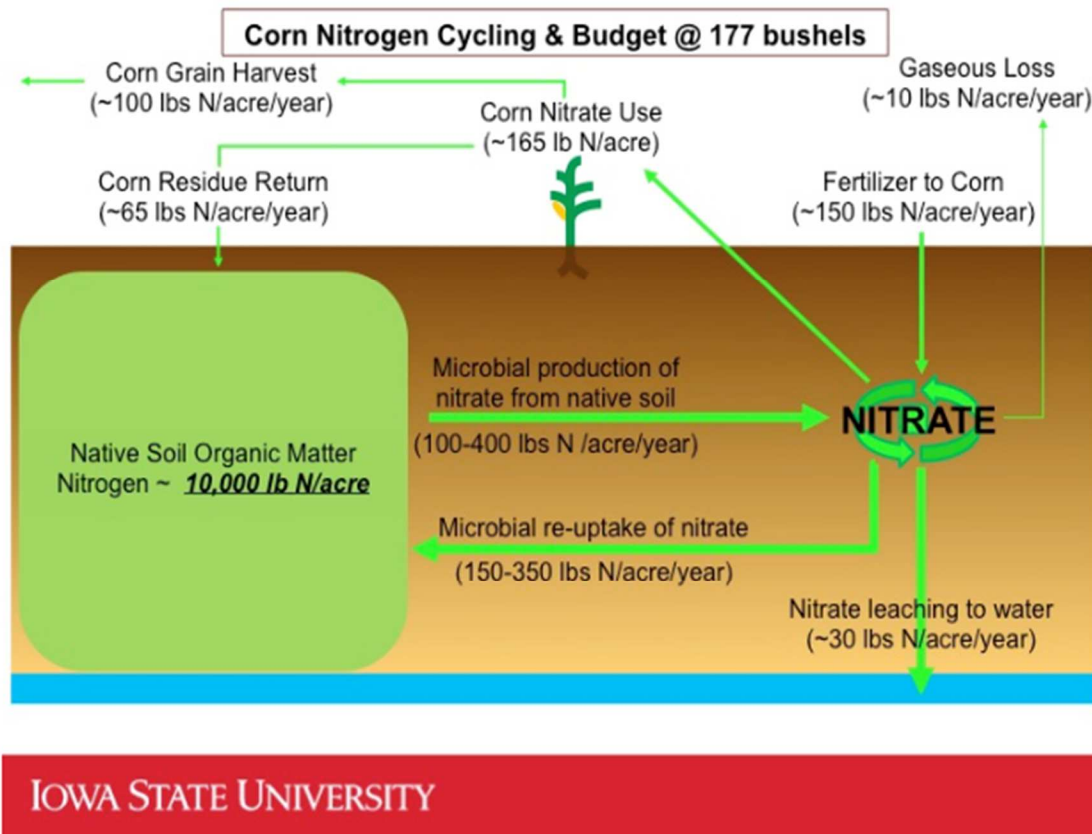


Figure 5.1 The natural nitrogen bank. From “Corn Nitrogen Cycling and Budgeting” (Castellano 2015).

Within this graphic, the nitrate is iconized as the center of focus and activity, the bright arrows drawing the eyes from the 10,000-pound native nitrogen green block at the left across the brown soil expanse. The thicker arrows showed the exchange between this green block of organic matter and the all caps nitrate. One thicker arrow, the infamous lost 30 pounds of nitrate, pointed down to a thin strip of blue, Iowa’s subterranean waterways (tile? an underground creek? the water table?). The corn plant was barely perceptible in the dynamic cycle happening in the soil. Its two roots seem faded somehow, not a part of the activity indicated by thin green arrows. This could be an

indication of quantitative differences, but the 30 pounds were as thick as the microbial-organic matter exchange, ranging 100 to 400 pounds. The fertilizer (an underestimated although recommended 150 pounds of nitrogen fertilizer) was thin, as are the corn plant's use, the harvest, and the residue. The air also was implicated at the same thin line, 10 pounds lost to the atmosphere. The soil—dark and deep—dominates the image. The corn plant, somewhat appropriately according to the research, did not play much of a role in the soil's biological activity.

A week and a half later, on December 2nd, I was back on the conference route, at the Iowa Farm Bureau Federation's convention, sitting in Dr. Castellano's talk, "Busting Myths with Real Science for the Greater Good." This was a title that drew in the audience. "Greater Good" was the theme at the Farm Bureau convention, and this myth-busting real science was intriguing. Initially, he did some situating of ecology and politics, discussing past and current issues with soil and water quality, as well as WOTUS (Waters of the U.S.), the DMWW lawsuit, and the NRS.

Then, he stated slowly and clearly, "Corn and beans are the largest source of nitrates, and we need to own that as agricultural community." I heard familiar phrases and saw similar images—"10,000 pounds" and a screen taken up by the brown expanse with numbers and arrows pointing all over (Figure 5.1). Then he said something I had not heard before. The problem was the same for all fields. This nitrate loss had to do with having roots in the ground. It remained a land management issue. He pulled perennials in, and cover crops, as ways to fill in the gaps created by commodity crops' short seasons, mirroring the *Register's* April editorial that I would read much later.

I kept taking notes, but this information jostled me. The absence of roots had been absent, erased I realized now, in the IAWA rep's talk, and Castellano described this as the central issue. Warm, wet soils usually occurring in spring encouraged soil microbes to wake up, and once they were awake, they began to convert 1-4% of nitrogen in their natural bank to nitrate. When there were roots, and where there was prairie, these plants would put the nitrate to use. Now there was bare ground for four to five critical months of the year, years that were getting warmer and wetter regardless of the season, so microbes stayed awake and productive for longer periods of time. The significance of this microbial and rooted alliance, I soon found out, was purposefully lost in stories about the soil, which became an independent laborer in cartographies mirroring the one I heard at the Farmers Union talk. Castellano's assemblage was lively, like the IAWA rep, but also disjointed and gaping within this liveliness. There was space to see the absent plant roots in this talk.

In trying to tease out the nitrate origins node of this shifting assemblage, the same cast of nonhuman actors—vital entities and technologies—kept appearing: commercial fertilizer, drainage tile, soil and its microbes, corn, soybeans, perennial plants, and plant roots. By triangulating from articles from different sources and ethnographic data, it became apparent that politics affected the obfuscation and amplification of particular vital actors, a process of entextualization. Who and what was enlisted in the making of nitrates then was a matter of assemblage desires.

Science has been enrolled in the past to legitimize particular perspectives. The specificity of citing particular Iowan researchers' names helped in terms of establishing lineage. Yet what made this nitrate origin story so communicable was its vital materiality.

The biological activity of the soil—its millions of microbes—was the source of nitrate. As I will continue to demonstrate, science and soil microbes had a powerful alliance. Yet the absence of plant roots made it all the more powerful, for either the inclusion or exclusion of this absence changed the story entirely.

Eller of *The Register*, who broke the story about nitrate origins, introduced it in much the same way as Castellano did at the Farm Bureau meeting. Iowa's soils became heavy with roughly 10,000 pounds of organic nitrogen per acre, and the soil lost 30 pounds of nitrate regardless of the corn or bean. Although Eller had mentioned natural sources of nitrogen before, the full, symbolically authorized origin story appeared on April 10, 2015:

Nitrates occur when Iowa's rich soils get warm and wet, and microbes convert nitrogen — both that farmers apply and what's available organically — into nitrates, which plants use to grow.

Problems occur, though, when there are no plants in the fields to soak up the nitrates — particularly in the spring and the fall — allowing them to seep into waterways, said Castellano and Helmers, an agricultural biosystems engineer.

Castellano and Helmers, representatives of scientific knowledge, were tied to the absence of plants and presence of nitrates, rather than microbial activity. Eller used their position as ratified speakers and principal experts to animate the absent roots aspect of nitrate origin story. In her reporting, Eller continued to circulate a version of the narrative that linked human and ecological activity. Natural nitrogen entangled with septic tank leaks and farm fertilizer runoff; cover crops, soybeans, and corn; weather, land use, drainage, and soil types. In the following excerpts, Eller (2015b) put drainage tile at the center of nitrate origins and consequences, and ends with cover crops.

But drainage, combined with changes in land use, also moves nutrients more quickly from farm fields to Iowa waterways, said Keith Schilling, a research engineer at the University of Iowa...

"The tiles in particular short-circuit a lot of the natural processing that would go on as groundwater would slowly move through the system," he said... Matt Helmers, an Iowa State University biological system engineer, said studies show crops in a corn-soybean rotation grown without applied nitrogen fertilizer also lose nitrates, although it's about 40 to 50 percent less than when fertilizer is applied...

Changes in land use also have contributed to nutrient losses, said [Sean] McMahon, whose group is funded by the Iowa Soybean Association, the Iowa Corn Growers Association and the Iowa Pork Producers Association. Since 1950, farmers have converted to row crops 10 million acres that once were pastureland or grew soil-holding crops such as wheat, oats, rye and sorghum, he said.

That change has meant fewer plants are using nutrients in the spring and fall, when Iowa sees the majority of its precipitation.

Eller's assemblage implicated tile, corn and beans, absent plants, and even fertilizer. She legitimized her assemblage with three speakers, two researchers (one at UI and the other at ISU) and one director of an ag group alliance, respectively, who all essentially had the same conclusion: humans have altered the landscape to the point that we have created ecological consequences. The final paragraph with citations from McMahon was particularly interesting, since it is unclear whether McMahon cited the drastic changes since the 1950s or the fewer plants, or whether Eller included this information in-between two of his direct quotes. Again Eller used sequencing to continually highlight the absent plant roots, tile, and fertilizer, all human activities in origin, and all implicated in the "nitrate problem."

Other reporters from *The Des Moines Register* followed her example, also pairing natural nitrogen loss with plant absences. Other news sources included this microbial connection, but not with the same clear alliance that Eller presented. Tom Cullen of *The Storm Lake Times*, for instance, on March 13, 2015, a month before *The Register's*

publications, stated, “The cause of high nitrate levels is runoff of nitrogen from agland, Stowe says. Excess nutrients—from commercial fertilizer, nitrogen-fixing plants like soybeans and microbial activity in the soil—are discharged through drainage pipes into watersheds.” The microbes were not allied with plants or fertilizer specifically, merely listed, and this account did not include the scientific context—with any reference to studies or researchers—for these microbes. Since *The Storm Lake Times* had positioned itself to find whole truths, it seemed unlikely that this inclusion purposefully spread the entextualized version of microbes-as-polluters narrative. Instead, this moment showed a small but apparent gap in the news reporting genre’s attempt to parse the scientific research genre.

In *The Gazette*, Erin Jordan wrote an article asking, “Are golf courses contributing to Iowa’s nitrate runoff?” on October 20th, 2017, and stated that golf superintendents considered course turf to be a year-round cover crop that prevented soil erosion and fertilizer runoff—possibly even purifying groundwater. “I’m not saying the ag guys don’t do a great job, but they don’t have a cover crop,” he [golf superintendent] said. This comment indicated the golf superintendent understands the alliance between microbes and plant roots. This tongue-in-cheek article hinted at a history of shifting blame and accountability between farmers and non-farmers, rural and urban people (Comito et al. 2012). However, the natural nitrogen narrative presented an unprecedented categorical difference in this history.

In *The Spokesman*, Dirck Steimel on December 7th, 2015, cited the same conference talk that jostled me with my revelation about soil microbes and plant roots.

Mirroring the panel title, Steimel framed the article as busting myths about water quality that “do not hold up to the scrutiny of science.”

For example, Castellano said, there is a myth that nitrate problems in Iowa waterways are primarily caused by farmers’ mismanagement of fertilizer. And that myth, he said, needs to be busted.

"Natural loss of nitrate is really the main thing that is causing us to lose nutrients into our waterways," Castellano said. "Fertilizer applications really have very little to do with it."

Iowa’s deep, black soils have on average some 10,000 pounds of nitrogen per acre stored in organic matter, the ISU associate professor said...

Mismatch of timing

Nutrient losses typically occur in the early spring and late fall, when microbes unlock a portion of that natural nitrogen but there are no crops on the fields to take it up, Castellano said.

"It’s a mismatch of timing of when the nutrient is naturally produced and when the crop roots can take it up that leads to the nitrogen loss into the water," he said.

Steimel did present absent plant roots and microbes, but only after creating a version of the narrative where fertilizer could be dismissed and a natural process connected to “Iowa’s deep, black soils” can be located as the origin. The way the narrative was sequenced, a reader could stop reading after this narrative, having both direct and indirect quotes from a ratified speaker, Castellano, as supporting evidence. If a reader continued, they had this natural nitrate loss coming from “Iowa’s deep, black soils” as their frame of reference for reading, which naturalized the “mismatch of timing.” The crops’ inability to take up the nitrate, their absent and erased roots, became part of the natural cycle. This was how the narrative could become an immutable mobile (Latour 1987 and 1988), where its partiality becomes whole and communicable. Sequencing, indexical calibrations, and drawing on well-established icons like “Iowa’s deep, black soil” all contributed to the communicability and mobility of the “natural nitrogen pollution” narrative (Briggs 2007b; Briggs and Mantini-Briggs 2016).

The narrative presented in *The Spokesman* emphasized the iconic “deep, black” soil, its natural fertility, and its microbes as the source of nitrate pollution (see Appendix E: Table E.1). Occasionally the narrative included absent plants and plant roots, yet several aspects of their framing made it appear natural. Fertilizer—a distinctly human activity—had been dampened as nitrates’ origin. By extension, farmers’ practices were de-linked from the soil and even plants, as in the undated report and on March 16, 2016: “Most nitrate loss to Iowa streams is caused by mismatched timing between the uptake of nitrate by growing crops and the natural microbial production of nitrate from nitrogen found in native soil organic matter.” Although crops were a distinctly human-plant relationship, here they existed outside of human activity, growing rather than planted. While this was an understandable fact since growing plants rather than young seeds could use nitrates more easily and prolifically, it allowed for plant development to become naturalized completely rather than assisted and tended by human-technical labor. The seasons of crops were thus presented as natural, as if planting and harvesting corn and soybeans were not human activities, and as if plants simply were not growing sometimes. None of the accounts included human actors very explicitly; however, several sources used proxies through companion/vital technologies, such as crops and fertilizer.

The comparison with prairie presents an important counterpoint.

“The prairie, which has never been touched by a plow, shows the naturally-occurring high organic matter present in north-central Iowa soils, [Brent] Johnson said. Soil tests show nitrate levels of about 7,100 pounds per acre in the prairie, which is almost twice as high as a sample taken from a nearby crop field, he said. The naturally-occurring nitrate makes the region’s soils among the most productive in the world, but also contributes to water quality challenges, Johnson pointed out.” Tom Block, *The Spokesman*, 7/23/17

Where Castellano and Helmers used prairie as an example of an ecology constantly using microbe-produced nitrates and a vital solution to nitrate loss, Block's inclusion is ambiguous. "Untouched by plow" suggests that prairie was hoarding this essential and problematic nitrogen and nitrates, far more and far worse than a neighboring farm field.

The Farm Bureau had others way of circulating this narrative as well, through visual materials. I took this photo at the Iowa State Fair in August 2016 at the IFBF tent, one of a series within a "Farming Stronger" theme (Figure 5.2). This quantitative comparison, 10,000 to 150 to 200, gave another impression that nature had far more ability to pollute than farmers. The farmer's quote (cropped) "By sampling my soil, I can apply fertilizer more precisely so my crops only get what they need, when they need it" also supported the idea that farmers were far more cautious and exact in their nutrient application than Iowa's soils and Mother Nature.

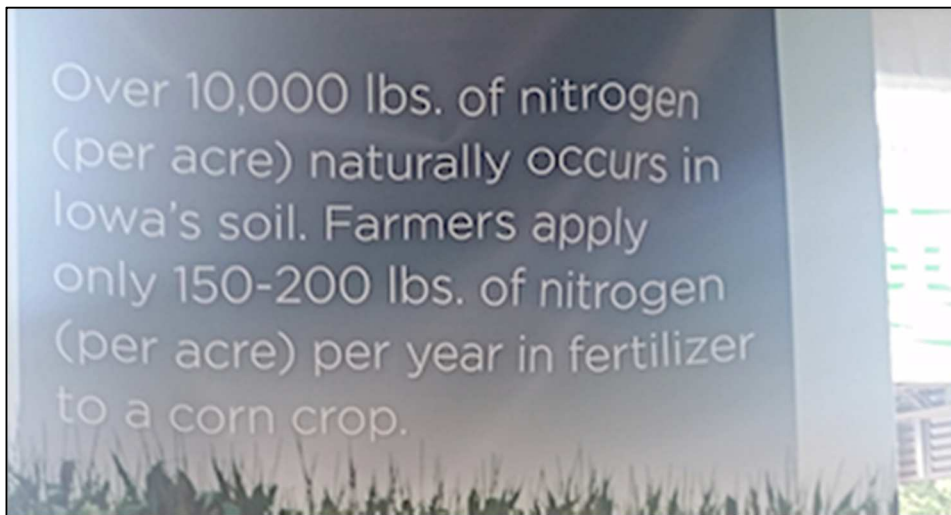


Figure 5.2 Comparing nature and farming's nitrate.

Another visual example came from the Farm Bureau's "Iowa Minute" series (Appendix #: "Iowa Minute" transcript). The video was posted to YouTube shortly after the researchers' editorial in *The Des Moines Register*, on April 23, 2015. In this short clip

titled “Nitrogen exists naturally in Iowa soil,” Laurie Johns, IFBF Public Relations Manager, was crouching over a garden bed, looking at a device that read nutrient levels in the soil, a small waterfall framing her in both auditory and visual ways. She clucked to herself, saying, “Looks like I’m gonna need some fertilizer if I want these to grow” (Figure 5.3).



Figure 5.3 Natural nitrogen in the garden

She then turned to the camera, breaking the fourth wall directly, and stated, “Did you know that Iowa’s natural soil fertility affects not just the plants that gardeners and farmers grow but also Iowa’s water quality?” Here she implicated the soil, but also non-farmers—the gardeners, and thus urban and suburban population. The video cut to Castellano in a windy field, walking along the edges of one bare field and one with rows of rye grass. The video labeled him as an Iowa State University Soil Scientist, with the IFBF logo in the right-hand corner. He echoed Johns, saying, “Average soil in Iowa, there’s over ten thousand pounds of nitrogen per acre in the soil, and the farmer might apply a hundred

and fifty to two hundred pounds of nitrogen per acre per year in fertilizer to a corn crop.” His statement, at “the farmer,” is accompanied by a graphic similar to Figure 5.1 (Figure 5.4).



Figure 5.4 Natural nitrogen bank version 2

In this screenshot, the soil and the bold letters proclaiming the 10,000 pounds of natural nitrogen dominated the screen. The tractor as empty and ghostly, only carrying 200 pounds at most compared to the 10,000 underneath it, against the backdrop of a bright blue sky and rows and rows of tall green growing corn. Castellano connected warm spring weather, corn and soybeans “not growing,” and nitrate loss, but neither absent roots or soil microbes come up during the rest of the minute. Cover crops and bare ground did appear, visually and verbally, but it was not clear why cover crops were a favorable conservation practice in this context.

At the time of writing this dissertation, it had been viewed on YouTube over 350 times (half a dozen likely by me). Whether in *The Spokesman*, at public events, or

through visual media, the Iowa Farm Bureau kept their narrative consistent. These visual examples show the multiple media avenues the IFBF pursued in spreading its ag-centric and ag-positive messages.

5.2 Editorials and Ethnography: Circulating Talk and Science

The two narratives of the nitrate origins—“Nature pollutes itself” and “Soil always needs plant roots to prevent water pollution”—became apparent in editorials and my ethnographic data. The former narrative had several advantages to the latter in terms of communicability, entextualization, and becoming an immutable mobile. “Nature pollutes itself”

1. Spread through *The Spokesman*, which has widespread readership and acceptability among farmers in particular. IFBF is seen as a farm advocacy group that many farmers appreciate, so often people felt IFBF had their best interests (re: corn assemblage desires) in mind.
2. Cited locally produced scientific research specifically.
3. Fit into a cultural pattern of distributing and equivocating blame from agricultural sources to other sources.
4. Blamed a source that farmers ostensibly had no control over: natural ecological systems, or “Mother Nature”/“Iowa’s deep, black soils”

In contrast, circulating the interrelated absent plant roots and soil microbes was less communicable. It did not fit into the corn assemblage desire, since blaming farmers for environmental problems was seen as an (over)emotional, irrational source for regulation, nor did it come from a source that specifically advocates for farmers. It also required an additional step in the research process. “Soil microbes naturally produce nitrates” could circulate easily on its own through one simple sentence. “Soil microbes naturally produce nitrates, and without plant roots to use them, the nitrates get into waterways” was more complex, required more explanation to fully make sense, and brought people back into the node of the nitrate problem.

After Steimel's report from the IFBF conference in December 2015, the natural nitrogen narrative circulated widely. While *The Register* had cited the research months previously, *The Spokesman* packaged it in such a way to make it more communicable, as outlined above. While within the newspapers themselves there seem to be conversation allowing for debate over nitrate origins, it is unclear how much people read the full dialogue.

One editorial in *The Register* on April 6, 2016 stated that "As has been pointed out by soil experts, the natural nitrate content of Iowa soil, coupled with snow, rain and a range of temperatures, creates problems that need a teamwork approach." Several weeks later, Donelle Eller quoted Castellano and Helmers again about microbial nitrate production exceeding the growth and use of corn and soybeans most of the year. While I took this to be a dialogue between guest columnists and journalists, I do not know how other readers did or would interpret it.

In *The Gazette*, on May 6, 2016, an Iowan hydrologist wrote,

We hear much about how Iowa soils inherently contain lots of nitrogen. What we don't hear is that our deliberate actions have greatly increased the water soluble portion of this nitrogen...Indeed, we have known for a very long time that most stream nitrate gets there via tile drainage... Secondly, the mechanisms connecting soybean and stream nitrate are probably less important than the loss of biological diversity that occurred as farmers transitioned to a two-row-crop rotation.

A farmer, Certified Crop Advisor, and guest columnist, wrote a guest column on May 22, 2016, "You have probably heard about how high nitrate levels in our water systems being caused by agriculture. The Environmental Protection Agency says these increased nitrate levels in our water sources come from several places including fertilizer runoff from fields, septic system leaks and the movement of naturally occurring nitrates. High levels of nitrogen are naturally a part of Iowa's black topsoil, on average it contains 10,000

pounds of nitrogen per acre of organic matter.” He was able to ally this natural nitrogen—using a sentence I noted in several news articles—with the EPA, an infamous authority among the Iowa ag community for its interventionist, punitive approach to the environment. Another guest columnist and farmer wrote on July 29, 2017, “Agriculture detractors who think that stopping the use of fertilizers and chemicals today will solve our problems tomorrow are themselves ignoring science. For example, nitrates, the center of the Des Moines Water Works lawsuit, occur naturally in the soil.”

Editorials then became a place where people convey their perspectives, becoming particularly communicable with the use of scientific authorities, in the above cases the hydrologist himself, the EPA, and ambiguous science. While there seemed to be dialogue among guest columnists, and then with reports, it also seemed another format through which to circulate immutable mobiles, either a “crops and soil microbes” alliance or simply “soil microbes.” Potentially, the editorials could be perceived as ratified speakers, since both farmers cite science and the EPA to improve their position. The hydrologist also cited science, as an active participant, but ostensibly, the citation of and actual participation in science could have similar levels of symbolic authority.

My interviews revealed to me the extent of the circulation of these two narratives, especially the communicability of natural nitrogen. In speaking to people, I realized that identifying the origins of nitrate pollution had further consequences beyond the entextualization and circulation of the research.

Speaking to a farming couple that also had a construction business specializing in drainage tile, I navigated with Bud and Lisa the issue of nitrate on a late summer evening at their lake house.

Bud: We naturally have a lot of nitrogen, nitrates in the soil, without adding to it. There again it's not readily available for the plant.

Lisa: That's the misconception. It's not necessarily the fertilizer floating down the river. I'm sure you've heard.

Lisa referenced misconception, summoning an ignorant, likely hysterical public that allowed fear to overtake their ability to understand reason and science. Similarly, Ellis, an older farmer from the North Raccoon watershed, stated,

[There is a] misunderstanding of some of the people where the nitrates are coming from. It's the decaying of the grass, decaying of the actual soil. There's enough nitrogen in the soil if we unlocked it, we'd have plenty of nitrogen. But we can't. I can't stop the corn stalk from decaying.

Ellis' framing demonstrated how the grass, the soil, the corn labors on its own, outside of human input or control. Like Bud and Lisa, he also connected this to the uninformed public. Caleb linked this natural nitrogen to regulation resulting from lawsuit, rather than the public: "We don't know what's going on with nitrogen in the soil. Natural organic nitrogen, it's higher than any we could put on. How do you legislate...[what] your soil has? I don't know how you legislate that." Caleb's account silenced crops and drainage tile, the latter being the crux of the lawsuit.

As I suggested before, the consequences of a natural nitrogen narrative extended beyond the realm of public opinion and politics. Steven, a farmer in his 40s in the North Raccoon watershed, said to me,

My farm out here is 5 or 6% organic matter. Each percent point of organic matter, it will exude 30 to 40 pounds of nitrogen. These were swamps. They're really high in organic matter. Naturally exudes them [nitrates]. □ I went to Great Lakes, the river there was flowing brown from the tannins in the trees up there. It was a natural process. It'd be interesting to see what the prairie did.

The 30 pounds and "naturally exuded nitrates" connected directly with the original study. Steven also linked to his own experience with the Great Lakes, where he recollected

visual evidence of natural pollution—a brown river. He then summoned the prairie, but not as a lively landscape. Prairie here became a source of pollution. To return to the assemblage chapter, recall Darren—a North Raccoon conservation expert—and Melvin—the former legislator farmer who verbally jousts with me as Bill Stowe’s proxy. Darren stated, “Normal prairie loses eleven, twelve, fifteen parts per million. That’s unplowed prairie.” I found this concerning since Darren worked with local farmers and could promote—or not—best conservation practices, and prairie restoration was one of them. In a more elaborate exchange, Melvin, in his hypothetical court appearance, had quizzed me about the wrongdoing of DMWW. Prairie was his second to last battleground.

Melvin: Well, okay, Iowa State University is on record. If you had a prairie and were taking water from under the soil, it would average 14 ppm.

Bri: I haven't seen that. [skeptical tone]

Melvin: Bill Stowe is asking us to do something Mother Nature hasn't been able to do. Is that reasonable?

Bri: That one not so much. I haven't seen that study.

Melvin: I think I'm right on that. I've seen it in print.

Melvin drew on the trope of Mother Nature, who cannot control her prairie excesses.

Even in instances where the human activity came into the assemblage, nature still held dominance. Jerry, a young farmer from the Middle Cedar watershed, told me,

I'd argue that even if crop production went down to zero, there would still be nitrates in the water. Nobody seems to realize that because of the natural systems. We just created an outlet for them...Going through the prairie process...Only thing we have changed is there is drainage. Otherwise it'd go down and down and down until it hit groundwater, and then it'd leach out [huffing laugh]. We just created a quicker outlet for it. It's a natural process. We've just manipulated it.

In Jerry’s analysis, tile was the only change. Corn and beans were silenced, suggesting they mimic natural systems of prairie enough to be of no consequence. To Jerry, prairie would do the same as the corn and beans, and leak nitrates.

When interviewing John and Will, a father and son who farmed together in the Middle Cedar watershed, they cited natural sources extensively, particularly John. John moved in and out of agriculture as a cause, once connecting corn and soybeans to nitrates. Will and my comments around cover crops give him revelations within the interview.

John: I'm sure you've heard this before...you could stop using nitrogen 100%, and you would still have nitrogen in the Raccoon River because of all the natural nitrogen in the soils. I don't even know what it is. Listening to guy from ISU from a conference, he made that comment [that] less than 5% of cover crops can soak that up when we lose that in the spring. Just the fact that we're producing the corn and soybeans, we can't stop doing that. What's the best way to do that?

By referencing “producing the corn and soybeans,” it was unclear to me whether John was presenting me with solely the “natural nitrate pollution” version of the research, or if he was recognizing the root cause was the corn and bean rotation, which “they can’t stop doing.” This ambiguity led me to discuss the research as I understood it

Bri: Corn and bean fields lose about the same amount of nitrates. It’s not fertilizer application. It's the timing. It's bare ground, active microbes, and rain. Soybean/corn are not using it. Cover crops can help.

John and Will responded to my explanation:

Will: But you have to kill them off early.

Bri: Cuz you don't want it to affect your crop.

John: The ground is constantly making nitrogen through microbial action. You do use cover crops to soak up leftover [nitrate]. Okay, but that doesn't stop the soil from producing more and more nitrogen. Cover crop decompose, and produce nitrogen theoretically. You know what I'm saying? I don't know if it's going to make a difference. Is it just recycling?

Will: If the hope is it gets tied up until corn starts growing in late July, I don't know.

Here John and Will reflected with ambivalence on the role of cover crops. Their short lifespans could make them ineffective at capturing nitrogen, and perhaps even add more

nitrogen into the system with their deaths. John ended that part of the discussion with more ambivalence.

John: That's the theory that ground is still generating as much nitrogen as previous years that added nitrogen plus the nitrogen the cover crops are recycling. I had never thought of that before...Bri, I just thought of this. In Virginia, in some river there was a study, waters going to Chesapeake? It was an impaired waterway. They blamed agriculture. This was independent study, a university. The vast majority of the pollution was coming from natural sources. Have you heard of that? A lot of people out there think if farmers would stop using fertilizer, water would be clean and we could drink out of the Mississippi. We obviously play a large part.

He tried once more to use scientific symbolic authority to center natural systems as the main polluters, yet he ended ambivalently by including the “large part” agriculture also played. With the communicability of the microbial production of nitrates, nature became a scapegoat for environmental degradation. This seemed particularly potent since the soil being blamed was also the soil enabling immense agricultural production, a paradox several of my farmers cited. Iowa’s fertile soil became both a blessing and a challenge. As prairie was blamed in previous excerpts, cover crops came under scrutiny in my exchange with John and Will. However, the problem with cover crops focused mainly on their role in the nitrogen cycle. Will provided the insight that the efficacy of the cover crop dampened due to the planting of a cash crop.

However, not everyone emphasized the soil microbes as the sole creators of nitrates. In several of my interviews, people explicitly discussed the absent crops/plant roots and their role in the problem. Nathan, the eloquent conservation expert I met in the Middle Cedar watershed, said,

They're saying it is all just naturally occurring. Until you solve the diversity issues, if you're still just growing corn and beans, [water quality] will just be a marginal improvement... In the media, from Farm Bureau, [they say] 'What people don't realize is our soils are very rich.' Any time your opening gambit is to lie about something...is the wrong approach...

When I asked Norah, a conservation expert in the North Raccoon about natural nitrogen, she began with the soil but continued.

Oh yeah. We have high organic matter in our soils. It's there. How to explain it? We farm the way we do we're going to have that problem. What was different was we had prairie. The plants used it. We didn't have the drainage that flushed it right out. There isn't any way to avoid that. Farmers say that, well it's there naturally anyway. Well, yeah. But it's because we've changed the landscape.

In both of these instances, the conservation experts pushed against the soil microbes circulating by themselves. They implicated corn, soybeans, and drainage systems in the problem and biodiversity as the solution. In one instance, Ron and Karen, an older farming couple I had met at the IFBF convention during Castellano's talk, parsed it in this way to me:

Karen: Mother Nature produces nitrogen itself.

Ron: Oh yeah. That's what the cover crops are for, to capture the nitrogen all the time [...] tile coming out of soybeans will have just as much nitrate [as corn with] 150 pounds of nitrogen over here and haven't been a pound put on the other. Most people blame what we're putting on. It's the excess that the soil makes. Extra nitrogen doesn't do any good on a legume crop. How do I make people in Cedar Rapids understand it's not the 150 pounds I put on that is the problem.

Again, I explained how I had understood the research, and Ron followed with his own.

Bri: It's the bare soil, right? Or no roots at the right time.

Ron: We could stop putting nitrogen on corn. Corn wouldn't look good, but there would be nitrates in the water.

Bri: I talked to researchers showing 30 pounds lost no matter what.

Ron: That's the 30 pounds we're trying to keep. It took me a long time to figure that out. I got to capture that before it gets away.

When Ron mentioned cover crops, he signaled the plant and microbe alliance. It did not seem that Karen understood completely, which I believe was why he jumped in, to fill in the gaps of her knowledge. Ron saw those thirty lost pounds of nitrates as something escaping a system without cover crops, which contributed to his steadfast support of the practice.

The mention of fertilizer, past the December 2015 conference, placed people as easily dismissed in the context of scientific ignorance, particularly for actors in the corn assemblage. Knowing how to engage with this research—that microbes/plant roots, not fertilizer, was the main issue—could create some legitimacy. In many of my interviews, people took on the role as my educator, which generally meant drawing on ecological science or agricultural knowledge. They would take the interview as an opportunity to educate a misinformed public—as Ellis and Lisa both did explicitly—or enlist me in the project of spreading “scientific truth.”

5.3 Not All Science is Created Equal

However, scientific research did not automatically grant ideas symbolic authority or ensure communicable reach. This became clear when I discussed the Environmental Working Group’s (EWG) study on decreases in grass buffer strips along waterways with Jerry.

Jerry: The Environmental Working Group’s study, I read with disdain. The methodology they’ve published, it’s flawed.

Bri: Could you tell me more? I’ve been to their meetings.

Jerry: It was on the downward trend in buffer acres. They didn’t do any ground truthing, just strictly aerial imaging. It’s fine as an assessment tool, but they’re treating it as God, and it’s not. Just because it’s torn up doesn’t mean it’s not there. Did they have to reseed it? You have to do it for contract maintenance. So there’s a few holes you can drive a truck through that assessment.

Jerry was emphasizing that EWG did not know the on-the-ground reality of why buffers

had disappeared, although it seemed to me that not all of buffer strips were simply being reseeded or that this was an invalid method for scientific assessment (see Environmental Working Group 2015). Rebukes like Jerry's happened often; when the results of studies were unfavorable to a particular group, the information would be manipulated. This happened in both assemblages, for example, soil microbes-as-polluters circulated widely in the corn assemblage. Issues like blue baby syndrome or increasing nitrate levels circulated widely within the prairie assemblage. The communicable cartographies within the assemblages demonstrated to me another way to differentiate assemblage actors and desires. It revolved around the issue of accountability. The corn assemblage tried to lessen accountability of farming because in this context, accountability was tied with regulation. The prairie assemblage tried to emphasize farming's consequences for the environment in order to facilitate change on the landscape, by voluntary or regulatory compliance, whatever the assemblage felt had most chance for success.

For months, when I had heard about the 10 ppm standard for nitrates in drinking water set by the EPA, people across the prairie and corn assemblages cited blue baby syndrome. Some did so with horror at the thought of children losing the ability to breathe and circulate oxygen, and others acknowledged this horror but asked me if I knew the number of known cases of blue baby syndrome since the 1970s (one, likely linked to well water was a common answer). The standard, they suggested, was a bit overprotective, a bit excessive, when people could just make sure that babies six months and younger drank water from bottles if they were using formula. Shouldn't six months old be breastfeeding anyway?

10 ppm seemed one of those inscrutable bureaucratic measures in many people's minds, including my own. Blue babies sounded awful, but how common was that? It also made sense to me that the protection could be for what science did not know about increased nitrate levels in the body and environment. Yet should nitrates be the focus when there were other issues with water quality? These conversations were in the wake of Flint, Michigan and lead poisoning from drinking water, and toxic algal-water blooms in Toledo, Ohio. A conversation over coffee on a cold January morning changed that question for me. A state level natural resource professional specializing in water, Marina and I had talked twice at this point, and her deep knowledge of Iowa ecologically, sociohistorically, and politically captivated me each time. She knew the infrastructure creating the trajectories of industrial commodity production in a way few other participants articulated so broadly and coherently to me. In our second conversation, she added complexity to how I thought about the 10 ppm standard. What follows is an excerpt from my field notes.

What surprised me most about this conversation was when Marina told me that nitrates have been linked to increased rates of cancer (Environmental Working Group 1996; Inoue-Choi et al. 2015; Kilfoy 2011; University of Iowa 2001). She mentioned four studies that have found that beyond 2 to 4 ppm of nitrates... [there are correlations] with four times the rate of ovarian cancer. It's also been linked with increased rates of stomach cancer, lymphoma, diabetes [...] Blue baby syndrome is not really an issue. It probably had to do with well water. The process to get new standards would take about 10 years. They're proposing monitoring beginning in 2017.

I was in shock. The researchers are nervous to publicize this information. I asked about controlling for other environmental toxins. She said, yes, nitrates are found in foods like deli meats, but the amount you would have to eat in comparison to the water you drink would have to be astronomical. University of Iowa has been doing studies with women in Iowa, a good population since Iowans tend to stay put, and may be exposed to the same drinking water source for decades [...]

I asked why Bill Stowe hadn't brought this up, and Marina said he didn't want to bring too many issues into this. He just wanted to demonstrate that pollution from tile lines are point sources [...]

University of Iowa had added a denitrification unit very quietly, which it could do since it was not linked to the public in the same way DMWW is. I asked why it was done quietly, and she mentioned not want[ing] to draw the ire of the university Board of Regents or the GOP, since they had already undermined the university in some ways with their university presidential selection. She knew [a reliable source]...In Lindquist Hall, nitrate and even nitrite were present at pretty high rates. Then suddenly one year it wasn't, which was when she asked questions.

She thought the public just would hear it was bad and did not want it in their water without too much additional concern. Others in the ag community interpreted it as drinking water busy work.

Marina followed up with links to several studies, which inspired me to contact one of the researchers knowledgeable about these studies. Here I also provide excerpts from my field notes.

This researcher told me about his work in drinking water contamination [...] [There was] data from municipal and public drinking water systems, looking into cancer and birth defects with help from the NIH and CDC. In 2001 is when they began publishing the nitrate data.

I asked why no one talked about this.

Professional organizations do, he said, in public health and drinking water. Citizens are becoming more tuned in. From the public health perspective, it was blue baby syndrome which made the initial standard, which is not a big deal. There may have been two cases in 2006, 2007[...]

We talked about how they had not found causation, but an association between drinking water nitrates and cancer rates. They considered drugs, diet, as well as nitrates in water specifically for ovarian, bladder, colon, and thyroid cancers. They have been following the same group of women since the 1980s, the Iowa Women's Health Study, with 41,837 women. [We talked a bit later about how nice Iowans are, the women are always willing to help.] They've been drinking from the same water source for 20 years, and exposed to low levels of nitrates and atrazine.

Bladder cancer and nitrates links have been corroborated in other studies. On the cellular level, bladder, colon, and thyroid cancers make sense, but ovarian cancer does not. It's been found in some animal studies but not human. Is it something else, the researchers have asked? They check for bacteria, viruses, herbicides. Is nitrate acting in synergy?[...]

Only Starla referenced the research to me unsolicited. I mentioned cancer to people occasionally in my fieldwork, including to the Iowa Environmental Council,

which later released a comprehensive review of studies demonstrating a relationship between cancer (as well as other health problems) and nitrates in drinking water. However, overall, studies about cancer were silenced, in part because several people told me the Iowa Farm Bureau had dampened its circulation by intimidating the researchers. These stories about the power wielded by the Farm Bureau occurred throughout my fieldwork. Their power was exemplified by a widely circulated editorial titled “Farm Bureau chokes Iowans’ voices” by Senator David Johnson, a respected Iowan conservative. The senator stated the state Farm Bureau (located in West Des Moines rather than local chapters) had convinced legislators that Iowans did not understand the Natural Resources and Outdoor Recreation Trust fund when 63% of them had voted for it. The Farm Bureau had also claimed it was a DNR land grab technique. This lobbying contributed, in part, to the Trust not receiving funding since its approval as a constitutional amendment by voters in 2010.

Science then circulated at highly communicable levels if coming from a respected source, and I had to ask, “respected by whom” as well. Iowa State had wide credibility with many of my participants because it is a land grant university from which many of them graduated it. ISU is seen as a space primarily “on agriculture’s side.” The Farm Bureau also had wide credibility based on its claims for farm advocacy. The Iowa Soybean Association was another well-respected producer association. University of Iowa, on the other hand, located in the very liberal Iowa City, had less credibility, specifically within the corn assemblage. Although Farm Bureau did not conduct research like the other three institutions, its political influence was substantial.

When I asked a long-time lobbyist in the state capitol's extravagantly beautiful library about whether threats of cancer would change the lack of action on water quality, he told me that if it is a disaster, like in New Orleans, that will change things. But slowly getting cancer would not. Policies and politics have to touch people's lives. Water quality does not, he hates to say it. Clean environments are way down on the list of care. He rhetorically asked and answered what people care about. He said it will not be water quality or the environment, but rather jobs and raises, or education for their kids. So despite the desire for slowness on the landscape from the prairie assemblage, the slowness of cancer and the slowness of the NRS showed that change would be incremental at best. None of these were disastrous enough to encourage proactive changes to the landscape or agriculture. Cancer simply did not exert territorializing power in his perspective, to reshape or change infrastructure concerning land management and environmental problems. However, the Farm Bureau thought it might have territorializing power, which led to suppression of their information within the state.

5.4 Concluding Remarks

This chapter revealed some of the techniques used to establish and maintain power/knowledge in its mass mediated forms of circulation. In addition to well-documented strategies of denial and equivocation (Comito et al. 2011, 2012, and 2013a), powerful groups like the Farm Bureau also manipulated research to serve their own ideological purposes. This is perhaps unsurprising in the age of "fake news." However, I suggest it is essential to document how this entextualization of scientific research can be done. This can force scientists to consider not only reporting on their findings but also the circulation and uptake of these findings, as well as circulating agencies such as newspapers and various agencies the impetus to make explicit connections between the

research and their audiences in their representations. Rather than discussing the natural nitrogen content of the soil, scientific and news reports could have simplified the message to something like this, “Living plants, specifically their roots, must always be present in soil to prevent nitrate pollution.” Some groups did have mantras hinting at this, such as Practical Farmers of Iowa’s slogan, “Don’t Farm Naked,” encouraging farmers to utilize cover crops. However, I believe this connection must be explicit to be effective.

Tracing nitrate knowledge provided me with additional insight into a more tacit infrastructure within each assemblage. The prairie assemblage cited that Iowa has one of the most altered landscapes in the states, transformed from deep-rooted prairie to agricultural fields, quarter sections, and small cities and towns. The corn assemblage talked about century farms and the changes—especially technological—in agriculture: no more moldboard plowing, tractors instead of horses, hog confinements instead of outdoor houses. The prairie assemblage took the geological history of the state as their starting point, enrolling glaciers and prairie in the creation of rich, black topsoil into their assemblage. The corn assemblage took the colonial history and the working of the landscape for livelihood as their starting point, where prairie met plow and human tenacity.

This temporal distinction, combined with nitrate knowledge, clarified the forces at work for each assemblage’s desire. The corn assemblage used farms and farming as the starting point for the landscape, which naturalized the agricultural environment. I suggest this made it easier to believe nitrates circulated due to the soil, rather than due to plants. The prairie assemblage used the prairie and wetlands as starting points, which made the agricultural environment unnatural. This left more room for nitrates in circulation to be

unnatural. Nitrate knowledge affected the conservation boundary object due to this natural-unnatural tension. When people told me nitrates were naturally lost, conservation through landscape revitalization lost potency. Farm continuity became the central concern because the public simply “did not understand science.” When others told me that the ground always needed to be covered with plants growing, this centered landscape revitalization and rocked the foundation of the corn and soybean system as inefficient. Nitrate knowledge then became part of de/reterritorializing efforts of the corn and prairie assemblage. Claiming a natural origin for nitrates deterritorialized the rationale for the DMWW lawsuit and reterritorialized the NRS because it was a more flexible infrastructure allowing for the unruly behavior of Mother Nature. It also created a perspective that farmers could only do so much, which weakened the conservation boundary object as a whole. Claiming an agricultural origin for nitrates reterritorialized the prairie assemblage’s critiques of the NRS and legitimization of the rationale behind the lawsuit, holding agriculture to account for environmental degradation.

CHAPTER 6

BRIDGING PRAIRIE AND CORN DESIRES

“We are walking on the ceiling of the underworld.”

- Quoted to me by Iowan farmer,
paraphrased from 19th century Japanese poet Kobayashi Issi

The dividing debates over nitrate origin knowledge were not the only things in circulation. There were multiple efforts to bring together corn and prairie assemblage desires—farm continuity and landscape change—because bridging relationships and actors of the assemblage—farmers, conservation experts, politicians, as well as cover crops and soil—could participate in both desires and serve the boundary object. In this chapter, I discuss three efforts to bring together local versions and assemblage desires: soil health, water knowledge (i.e. water monitoring), and technologically-mediated knowledge about the landscape, or what I call technological land epistemologies.²⁵ Each of the efforts tried to bridge between prairie and corn assemblage desires. Generally, these efforts originated from the prairie assemblage. They came in three interlocking forms: bridging/merging, filling in gaps, and expansion of a path. Soil health—circulated at field days and conferences as well as within mass media—attempted to merge prairie and corn assemblage desires. Water monitoring—done as citizen science projects, watershed projects, or statewide measurement initiatives—attempted to fill in gaps. Technological land epistemologies expanded the path of the corn assemblage to include

²⁵ Technological land epistemologies came up less often than soil health or water monitoring in my fieldwork. However, it is significant enough to be worthy of mention.

prairie assemblage definitions of conservation, coming up at conferences and in my interviews the most often. Soil health and technological land epistemologies attempted to “meet farmers where they were at,” by imagining corn assemblage-type desires. Water monitoring was the prairie assemblage’s attempt to address their critiques of the NRS.

6.1 Soil Health

“I don’t care about water quality honestly. It’s all about soil health.”

– Calvin, row-crop farmer

Although people rarely told me they did not care about water quality (in fact, usually people relayed some version of “we all drink this water, so I don’t want to ruin it either”), I found Calvin’s statement striking. Many people had thrown in their support of “soil health,” believing that this would provide the answers sought by those within conservation and farming. It was a rallying cry, taken up enthusiastically by various agencies and groups, such as NRCS and the Corn Growers Association (CGA). They ran media campaigns, held meetings, field days, and conferences; created demonstrations to educate about soil health; offered soil testing services; and designed on-farm research projects to monitor and develop guidelines about soil health. Several people told me that agricultural science had exhausted the physical and chemical realms of solutions to agro-environmental problems.

Darren: A cover crop could hold that nitrate and keep it in place. But it costs us...But we need that biological response, if we want three hundred to five hundred bushels of corn. NRCS and ISU are encouraging that. We’ve taken it as far as it can go. With easy fertilizer and hybrids, maybe we can continue to get another five ten bushels, maybe not. But soil biology and soil health is the next step. Most producers, they don’t understand the soil biology part. We want to keep that soil active, that biology healthy. That’s what we did before commercial fertilizer. We had cover crops and manure to keep the biology active.

Bri: Right, they called it green manure.

Darren: They would grow a small grain, plant something else, and plow it under. That was eighty years ago.

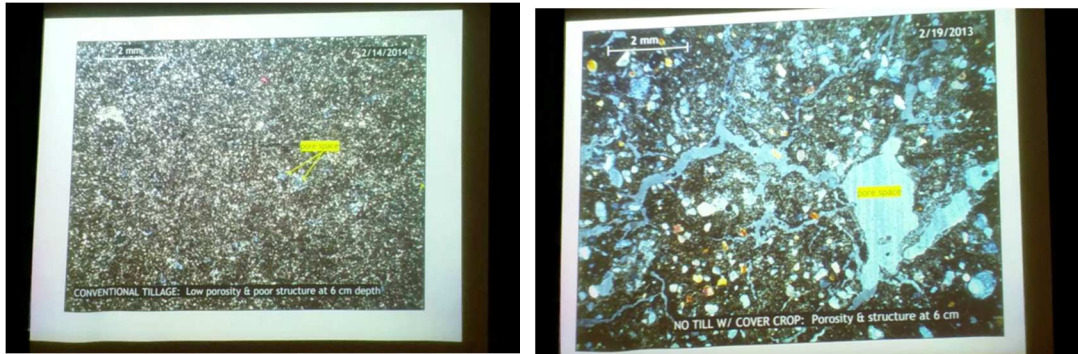
Tillage and artificial drainage as well as chemical inputs like fertilizer and pesticides had reached the limits of their potential for improving agricultural production without drastic consequences. Now people were turning to biology for solutions, specifically soil biology, translated to soil health. Darren emphasized that the idea behind cover crops—supporting soil biology—was not new. Soil biology was the new frontier in crop production, at least in terms of marketing soil-health practices like reduced and no tillage, and cover crops.

What exactly did soil health mean, though? As Darren said, producers did not always understand the soil biology part, and neither did I. What was soil “health”? What was soil? Why was it important to support soil biology? The complexity went deeper than keeping the soil “healthy, active, and alive.” Why did this feel like a public health campaign to get soil to exercise more and eat right?

I pieced together the answer throughout fieldwork, with the practices promoting soil health “tenets” becoming clear first, and the nature of soil and its health last. It was the instrumental knowledge circulating most widely, but speaking to soil scientists, watershed coordinators, and farmers, I came to understand the wonder of the soil itself. The transition of considering soil to be an economic resource and ecosystem service provider to being a living vital entity and in relationship with humans has consequences for agricultural and state politics (Lyons 2014; Puig de la Bellacasa 2015).

As I have emphasized throughout this dissertation, soil is a living ecosystem, and the biological entities of the soil make it the vital substance it is, allowing other kinds of life to grow from it. About thirty-five years ago, soil quality was the older term that encompassed all the qualities of soil—physical, chemical, and biological (Wallaces

Farmer). Soil health, though, emphasizes the biological aspect of soil. Physically, soil is made up of sand, silt, and clay, and the physical and chemical bonds between these creates aggregates of soil (Figures 6.1 and 6.2). These structured parts of soil provide space in the soil, for roots and other life. Together these components help retain and filter water (clay and water, respectively).



Figures 6.1 and 6.2 Slides from soil health presentation in Cedar Falls. Left, conventional tilled soil showing lack of space between soil particles. Right, no till and cover cropped soil showing space between soil aggregates.

Soil chemistry includes the elements necessary for growth—potassium, phosphorous, nitrogen, and even sulfur and zinc; pH levels; and organic matter. Soil biology is measured by “the size and diversity of the microbiological population. It is estimated that in 1 gram of soil (enough to fit on top of a nickel) there are 1 billion living organisms, consisting of roughly 10,000 species” (Wallaces Farmer). These billions of bacteria and fungi are the laborers of the soil, some competing and others collaborating with plants, trading nutrients for carbon or other needs the microbes cannot supply for themselves. These exchanges help create biotic “glues,” as one soil scientist described it, that helped soil aggregate stability (see Figure 6.1 for aggregate structure). This labor produces organic matter, and organic matter increases of 1% can help soil retain 10%

more water, or put another way, hold up to eighteen to twenty times its own weight in water.

Dr. Jim Friedericks, an education and outreach coordinator from AgSource Laboratories, related the chemistry, physical structure, and biology of the soil like this, ““For example, soil compaction (physical) limits the drainage of water through the soil which in turn increases nitrogen losses (chemical) through microbiological reduction of nitrogen in the soil’s organic material (biological)”” (Wallaces Farmer). Fredericks recommended cover crops in his article because increasing organic matter helps create a nutrient source for the soil microbes.



Figures 6.3 and 6.4 Making soil visible. Left, biological culture of garden soil at Cedar Falls soil health talk. Right, anthropologist observing soil loss test, showing water’s effect on differently tilled soil

The application of soil health was generally put into the context of resilience.²⁶ At one conference, a USDA scientist described the goals as stabilizing extremes in the soil, figuring out how to seal soil off from losing oxygen content, and managing the biology.

²⁶ Resilience has a complicated history and utility in socio-ecological discourse that I do not discuss here. However, it is important to note that resilience has become a coded way of indicating climate change. Several participants told me the state government had barred researchers from using climate change in their grant applications, preferring resilience.

Whether it was drought or increased rainfall, organic matter was key to absorbing and retaining water during climate extremes. Resilience provided a foundation for connecting economic and ecological interests. However, like many living beings, soil and its health often escaped measurement and quantification that demonstrated economic and ecological benefits. Jerry, a row crop farmer and SWCD commissioner told me, “Everyone's talking soil health now...there is no standard for what soil health is. Experts have different ideas. We don't have quite enough data or resources. We are just scratching the surface. We really don't know what's going on out there.” A small-scale diversified farmer lamented to me that she had been building her soil's health for years and had no way to figure that into the value of the land as she was looking to sell to the young farmer taking over her operations. Farmers told me about the qualitative change they could feel, see, even smell in their soil after using practices like no till or cover crops. The soil was mellow or springy. The soil was so biologically active that nightcrawlers ate crop residue down to nothing. The soil had a detectable smell, mineral, fungal, rich. Measurements had been developed like the Haney soil test, but this had received criticism as it was a comparative measurement system, using Texas soils as the baseline. Iowa Learning Farms had been developing an earthworm quantification method at the time of my fieldwork. I was particularly fond of the “soil my undies” method, where biological activity of different fields—tilled, no till, pasture, cover cropped—was tested with cotton underwear being buried in each for several weeks. The tilled undies were often fairly intact, while the other three were in varying states of holey disrepair, showing the presence of soil creatures through their voracious appetites.

Still, connecting these various tests to economic and agronomic benefits was difficult. The impact on yield was uncertain. With careful management, farmers saw no impact on their corn yields, and sometimes slight increases. But the management part could be difficult, depending on weather in the spring, essentially farmers' ability or knowhow to kill the cover crop in enough time to plant their corn without yield impacts. Ralph, an ISU researcher and administrator, mentioned the law of diminishing returns to me, that organic matter increased on most Iowa soils would not return what had been put into it. Yield was the number people wanted to be able to address.

Soil health is a good initiative, important. To increase production, to fix water quality issues, we have to pay attention to soil health. But soil health is hard to tie it back to the financial. How to put money into the pocket. What is soil health? We have to get better at explaining that. Do I believe in it? Yes. Do I think it's important? Yes. How do we get the message out? We need to simplify the message that people can understand it and quantify the benefits.

- Austin, public conservation expert

Austin took a broader approach than quantifying simply for yield. I wondered if there were other quantifications, if soil health could lead to less need for inputs like fertilizer. However, fertilizer applications were security for most farmers, and many expressed anxiety about trusting soil tests telling them their corn did not need any more fertilizer (see third section in this chapter). This quantification felt limiting because I was uncertain which numbers mattered and which could be impacted by improved soil health. Yield did not seem like the best goal either to me, since there was more supply of corn rather than demand, judging by the typically low prices for corn and the support of international trade deals opening up new markets.

Additionally, people were not so certain that promoting soil health was a good idea. Similar to John and Will's critique of cover crops in Chapter 5, Eric, a conservation

expert for a private company, critiqued the emphasis on cover crops. Soil health was about organic matter, and it was a leaky system. Cover crops were terminated while this system would still be leaky, and building organic matter could exacerbate the problem. Therefore, his group emphasized edge of field structures, which he also saw as having more permanence than cover crops, which could be abandoned after a season.

Despite some hesitation around soil health, it was an alliance, a mediating pathway, between the prairie assemblage and the corn assemblage. The biggest advocates for soil health expressed to me that this kind of approach would make farming sustainable and regenerative to the landscape. To consider in more depth this potential of soil health, I discuss two components of demonstrating it that stood out to me as attracting curiosity.

6.1a The cartography of virtual rainfall.

The NRCS rainfall simulator—out of anything I saw during my fieldwork—could have a powerful impact on the people gathered there (Figure 6.5). The machine brought together soil from different histories and experiences into a virtual rainstorm for the benefit of the crowd before it. This virtual experience—Deleuze’s potential—allowed people to witness and imagine this event spanning out across their own watershed or on their own acres, rented or owned.

Typically, the group gathered around the simulator, a table with several trays of soil, white boards behind and in front of the soil trays, and plastic buckets hanging in front of the soil trays. A pole arching above the trays would simulate the rain. The tray would hold soils treated differently, typically from the same area. In Figure 6.5, the dark soil on the left is conventionally tilled, the middle is cover cropped, and the far right is no till with crop residue left on the field. The NRCS staffer explained that the machine

created a fairly intense rainfall, falling at twenty to twenty-five miles an hour, roughly six inches within an hour. Even lighter rains are still ten to fifteen miles per hour.



Figure 6.5 Rainfall simulator. NRCS employee instructs crowd, especially the fascinated young boy in foreground, in the secrets of the soil revealed by the rainfall simulator

In this simulation, he would let the machine run for ten minutes to allow for an inch of rain. He directed our attention to what was happening on and in the soils. We watched as rain splashed black, tilled soil onto the white headboard. We watched as water filled (or not), clear or dark, the buckets in front, showing the impact of rain on soil erosion. After the minute finished, we saw that tilled soil and no tilled soil had nearly equal and dark levels of simulated rain. The cover cropped soil matched in level but not in color, with a murky beige rather than black inch of water. It took 400 to 600 years to make an inch of soil, he said, which, staring at the dark water, weighed heavily on the heart.

Then the NRCS staffer revealed a mystery: the white board below the trays hid three more buckets. These buckets revealed rain's infiltration into the soils. The no till soil held an inch or so of dull amber water. The cover cropped soil held several inches of water, the most of any bucket, a dark amber color. In stark contrast, the tilled soil held no water at all.

The staffer, after holding up the buckets for us to visually investigate, took out the tray holding the cover crops and dumped it on a black tarp. The bottom was wet and dark. He performed the same maneuver with the tilled soil. He reached down and pulled let dry, crumbly soil fall from his hand. The rain had not come through the soil at all, without any gaps or paths made by root, insect, or otherwise to travel through.

During this revealing, people would exclaim with wonder. A farmer asked me later, “did you see Bill Stowe?” and I realized the tall man with wavy white hair next to me, murmuring, “Wow,” had been the DMWW director himself.

Ron—a cover crop evangelical if I have ever met one—told me about trying to convince his neighbor to use cover crops. It was the rain simulator, he said, that made everything click for his neighbor, seeing water, soil, and plants in action, to see the effects on infiltration and runoff.

Still, the rainfall simulator did not always work (Figure 6.6). One NRCS staffer recognized me from another field day, where the results had gone awry. He explained he had made the mistake of wetting the field samples before coming to that field day, which had changed the typical outcomes of the simulator.



Figure 6.6 Dead cover crops, living cover crops, pasture, conventional till, and no till on display for the rainfall simulator

In Figure 6.6, the NRCS staffer explained that simply by removing the samples from the field, he loosened soil that otherwise would have stayed together, specifically comparing the pasture and the conventional till ground, which both had equal amounts of deeply murky water.

The power of simulator was in part, as Comito et al. (2011) as well as my research have shown, due to its visual witnessing. Water quality was often judged by sight, and clear water was seen as an indication of good water quality. This demonstration showed poor water quality through the loss of soil, turning water dark with the “rich, black” soils so beloved within Iowa.

6.1b Soil health testimonials.

Asking farmers to speak about their experiences with cover crops or soil health varied in the tone, but it was only when speaking about soil health that I saw some farmers took on the feeling of a testimonial. Conservation experts—often NRCS staff or soil scientists—also would adopt a testimonial quality when speaking about soil health. Testimonials happened at field days as well as during interviews and casual conversations. I knew a testimonial was happening if people drew on the following linguistic and discursive resources:

1. Reference to soil health gurus, especially Ray Archuleta
2. The tone of voice, which was usually reverent, awed, wondrous
3. Citation of the four (or five, sometimes) “tenets” of soil health
 - a. armoring/covering the soil
 - b. minimizing disturbance (i.e. decrease tillage)
 - c. increase plant diversity (i.e. use cover crops, especially “cocktails” or multispecies planting, and/or utilize more perennial/diverse crop rotations)
 - d. always have live roots in the soil
 - e? add in grazing or foraging livestock into operations.
4. Evangelical impulses, i.e. encouraging neighbors or other meeting attendees to look up Archuleta or specific research and consider practices like cover crops or no till.

5. Use of metaphor (e.g. soil should be like baked cake, not cake mix/flour)
6. Shrinking geographic space
7. Occasional framing themselves as being “unusual” in terms of interest in soil health

These resources defined, in part, the genre of soil health testimonials, but how communicable, entextualized, or mobile they were is a question for another study.

However, from my observations, soil health testimonials seemed to have the ability to reach some people. Indeed, from the people, especially farmers, I spoke with, attending a meeting with Ray Archuleta or his like had had a powerful impact on them.

Testimonials happened during public events as well as in private conversation. What follows are excerpts from my field notes from three different events where testimonials occurred: a farmer testimonial at a conference, a farmer testimonial at a field day, and a soil scientist testimonial at a field day. At the SOIL—Sustaining Our Iowa Land—conference in 2015, Wayne Fredericks, an Osage County farmer and ISA President, spoke in a session titled “How well is the Iowa Watershed approach working?” He introduced himself by his watershed, Rock Creek, and the farmer-led watershed planning that was the first of its kind to address the NRS. From his participation in that experience, he outlined his recommendations on how to scale up watershed projects. He tied his final recommendation, empower farmers to change, to the fact that “we need to get farmers to understand that tillage is detrimental to soil health.” Farmers still believed horsepower and steel make soil health better, Fredericks said, so keep up on the education since there was a 150-year tradition of tillage. In economic tough times, people would hold onto traditional practices. Go to neighbors and tell the story of soil health. An audience member asked him, had this worked? Did all it take was Wayne encouraging neighbors and friends to talk about soil health and have the discussion at Christmas with

mom's cousins? He confirmed this kind of technique did indeed work "real good."

Wayne was not speaking so much to farmers but the people working with farmer. They needed to understand the agricultural context in order to spread soil health gospel.

At a soil health field day, Grant—a well-spoken, tall, bristly balding farmer—told the room he had two main things he wanted to start with in his sermon. Water quality was the concern now, with the Des Moines Water Works lawsuit. But even before that there was the dead zone, and we were sending our share down the river. We were not alone in this. But factories had to monitor their pollution. Farmers thumped their chests as the best environmentalists, but we needed more action than lip service, he said.

Grant referenced the Fertile Crescent, the birth of civilization, saying it was where Iraq was now. Was it fertile now? No, it was desert. Think about the anger and unrest there. He saw an interview or article, which claimed if people were well fed and could grow decent crops, civilization flourished. Now he was not saying that American culture would collapse without good soil. But this was some of the best soil in the world. Sure, the Ukraine and Brazil were growing crops, but they didn't have good fertility or the infrastructure. We needed to hang onto this resource. Cover crops could help us.

He had been doing cover crops for ten years, using them for silage. He discussed some benefits and drawbacks of different cover crops, but rye grain could get you a cover fast. He also gave numbers, as he promised at the beginning. He paid about \$12/acre for seed, \$1 for getting it on the ground, and free labor from his father-in-law. He grew it for neighboring dairy cows. If you had cattleman next to you, use that resource, he said. He likened cover crops to the church plate. If you don't give now, it could keep some money in your pocket, but in the long run, it would hurt you.

After Grant reviewed how he did, and the benefits he saw (slow organic matter increase and weed control), farmers asked him questions. This revealed some of their own concerns—rye getting into the soybean harvest or insect damage. My neighbor was a farmer who made quiet comments about Grant’s “sermon.” He dismissed the planting method using a highboy since it could damage the stalks.

At another field day, Rick, a somewhat goofy, enthusiastic NRCS staffer, got up and gave an excellent, comprehensible presentation. Rick came to Iowa in 1993, right during the flood year. His passion was in agriculture. He farmed for a while himself. There was no better soil than there was in Iowa except Crimea—why did people think Russia wanted Crimea so badly?—and the Yellow River in China. We must take care of our resources, he reasoned.

Rick cited the four tenets of soil health. For little to no disturbance, he said this may not work for your system. The last three though he drew a hard line on. He said corn and beans, corn on corn were not diverse systems. The weed that escaped that everyone talked about at the coffee shop did not count. This was where cover crops came in.

He discussed the loss of at least 50% of the topsoil that came from prairie. Why was this happening? It was a short-term outlook. You wanted to know what kind of money you could make this year. And it was about easier management. If you had told him to put on cover crops early in his career, he would have said you’re crazy. Control your controllables, he said. There was so much you could not control like weather, so don’t add anything to it. Or so he thought.

He did the aggregate test (Figure 6.4.). He said, it didn’t really matter for soil type with no till or till; the effect of tillage on any soil type was the same. The no till was

noticeably darker, he pointed out, showing 1 to 2% more organic matter. The crust that was seen on top of a tilled field was not the impact of the rain but the rain shifting the fragile, less aggregated soil into a sheet.

Rick also talked about the biology and how mycorrhizae fungi could increase the nutrient uptake up to eighty to ninety percent in trees. He also talked about the weight of bacteria, roughly two thousand to two thousand five hundred pounds per acre. In a tillage system, bacteria were favored, while, in no till, it was fungi. The death of soil bacteria increased the nitrates in the fields. Without cover, soil heated up, and water was used to cool the plant rather than help it grow after the soil temperature gets above one hundred degrees. He showed a video of earthworms making middens (covering their holes with residue during moonless nights so they had food for bright nights). He seemed to frustrate the organizers since he said no till could mean less residue as the worms did really well and ate it all. But he recovered by emphasizing the importance of cover crops.

He talked about corn and soybeans having a seven-month brown gap that needed to be filled with something alive. He showed charts where there was less water coming off fields with cover crops and more nitrate being scavenged. He had a list calculating the value of different nutrients in the soil, and his calculations showed an acre of soil equaling about \$563 dollars. A farmer asked about this, incredulous that so much nitrogen was in the soil. An organizer said, but that did not mean it was available to the plant. Another farmer nodded in agreement vigorously. Rick said, we do not understand soil biology (one of the organizers did not seem to like this either). He talked about the nitrogen from fertilizer being put on a field, or maybe phosphorous, and it not showing up because the soil and soil biology was so starved for it.

I cannot say what the effectiveness of soil health testimonials was. Sometimes it seemed certain soil health spokespeople were considered strange, too out there because of their enthusiasm and dedication to soil health. Sometimes, as with Rick's presentation, speakers would say things the organizers did not want or like, showing the risk of the oral presentation. Other times they were well-respected farmers or researchers in Iowa. I also encountered plenty of presentations using impenetrable jargon. When I asked farmers who they trusted, with rare exception, they said, other farmers, sometimes only themselves. Trust came down, in many of their minds, to having had done the work of farming. When field days or conferences had farmers speak about their experiences, this gave other farmers and people working with farmers someone to be their baseline. What differed about this farmer's operation? How did his geography affect his results? They could navigate these variations to consider how such soil health-promoting practices might affect their land and operation.

Of course, when people did not agree with the results, they could use the farmer's unique position as reason to dismiss it, at the same time they needed farmers' evidence of practices working *in situ*. As I've discussed, farmers were at once the same in their general occupation and quite variable in their experiences and situations. If farmers had livestock or owned most of the land they farmed, these were often seen as separating factors that could determine the applicability of cover crops or not.

In interviews, particularly with "converted" farmers, I would witness the power of soil health in their ideologies. Ray Archuleta came up in these conversations, often signifying a turning point in their perspective. Archuleta sparked curiosity and intrigue, enough to send them out looking for more information. A couple of farmers told me

about Jean Prior's book, *Landforms of Iowa*, which these farmers used to emphasize the beautiful diversity of the landscape. After three and a half hours of interviewing, Richard opened a map to take me on a loving, marveling virtual tour of Iowa, spanning geology and culture, pointing me to the Dutch tulip festival of Pella, the Amana colonies, the loess hills, the rolling landscape of Decorah, old prairie, the lakes of the northwest corner and the Des Moines lobe. This was an act of love for the land that Richard wished to share with me, mixing culture and landscape.

I do think these handful of farmers who reverently shared soil health gospel with me were different. I had several conversations with them and others about what made the difference. Diversified operations with livestock; owning land; ethnic heritage; and a history of familial conservation all seemed like candidates, but not sufficient, to explain what made them open and interested in an uncertain science like soil health. Ron, an avid cover cropper and no till farmer, told me that

We [farmers] got away from what the soil needs. That's what brought me back□- was the no till. That's what brought me back to what the soil needed. It's a living soil. I think it will make a difference. It made a difference to Karen [to learn about it]. She went to a soil health meeting. They're all the same. They do that water sample. I saw that at Archuleta, blew my mind him planting in tall stuff.

You tell me why I change. I wish I knew. I consider myself an early innovator. I really don't know why I change, why Casey and Landon changed. Isn't that social engineering?...I don't know how to fix it [water pollution]. It won't get fixed with a bunch of engineers, conservationists, and environmentalists sitting in a room trying to tell us what to do.

Despite the testimonials, Clint summarized succinctly what was required as evidence for other farmers who remained to be converted.

A guy like Casey, who is highly visible and respected—if they can show third party soil health improvement, higher organic matter, soil loss equation is nominal, kicking the roof off the house in terms of yield, with cereal rye that is thicker than hair on a dog's back, no need for herbicide, then you got something to talk about.

The hurdles in Clint's mind to becoming a soil health proponent were showing the impressive spread of high yields and fertility, no erosion and no pesticide. So while proponents may have been convinced, it became apparent what was on the line for cover crops failing and succeeding across the landscape.

6.2 Water Knowledge

Water monitoring filled in gaps embedded in critiques of the NRS and watershed demonstration projects. Without measurement, the NRS's 45% reduction goal was amorphous. 45% from what? Measurement could help determine where the certain practices were most needed on the landscape, aiding initiatives like Watershed Management Authorities (WMAs) and other watershed planning efforts.

Monitoring required knowing the landscape in a different way. Unlike soil health, which relied on more abstract scientific knowledge, this water-land knowledge was gathered through data collection. Monitoring demanded local information to deliver a nuanced science, tailored for specific watersheds, and it considered the particulars of the land.

During my fieldwork, there were several ways water was tested. Citizen science projects like IOWATER organized “snapshots,” or statewide sampling that mainly consisted of on-site testing once a season. Some watershed demonstration projects did regular testing, like Ian's bi-monthly sampling trips I accompanied, which the project sent into a lab for testing. The Iowa Flood Center (IFC) had (and still does) a water

quality monitoring project with sensors that took regular readings in their waterways during the months when the waterways had thawed.

In Chapter 3, when introducing the human and nonhuman actors and contexts of the assemblages, I described Ian and my adventures while sampling. For this kind of sampling, collection of available water samples was the only objective (although it required extensive time and labor).

Citizen science projects and the IFC's project were different. Citizen science projects rarely included collecting samples for lab testing, mainly due to funding cuts to the IDNR. Instead, water monitor volunteers would go out to different sites and run a handful of tests, which included visual and chemical tests. During my snapshot experiences, water monitor volunteers and I collected data on transparency, pH, nitrite and nitrate, dissolved oxygen, phosphate, chloride, temperature, and sometimes flow of the water. Several of these tests included using strips and drops with reactive chemicals to create a color change that we then compared to a standard.

Several people told me they did not trust these kinds of results because it often relied on color comparisons that were imprecise. After having done this several times, and seeing that indeed chemicals could go bad and then I was without strips, or colors were sometimes in-between, I understood their perspectives. But as I spoke to different volunteers, and did the tests with them, these numbers derived from colors took on significance for the river or creek we were working on. This, I thought, was embodied environmental knowledge (Figure 6.7). To know that waterway, even if only for ten or fifteen minutes, required labor, observation, and time. It often included reflection about what could cause particular numbers. Many of the volunteers I spoke with expressed

prairie assemblage desires; this became a way for them to know their landscape and others who loved and wanted to know the landscape. This gave them evidence for positive or negative changes. It gave them a chance to be a part of science. This democratizing seemed valuable, despite room for error.



Figure 6.7 Citizen science in practice, featuring technical aids

At an IOWATER training, the lead scientist and organizer described water monitoring as a data-providing tool for communities and individuals to make informed decisions. She told us a story about what makes good science. She said, I know people talk about science as being objective and how good scientists do not have an opinion. As a scientist, I have a lot of opinions, but being a good scientist was allowing the data to inform my opinion. For example, I was going with some Boy Scouts to a creek, which they predicted would be very dirty, and they found very good results, which left them full of wonder. Saying “I don’t know” could be a powerful, useful thing to do. The organizer

conveyed a kind of knowledge that emerges from experiential data, connecting perspectives to what the test results showed.

These trainings were similar to field days, and the snapshots were similar to watershed monitoring, yet the difference lay in the opportunity for embodied knowledge for and from amateur scientists. We all heard the same information and were able to practice the same tests. During one training I attended, as people introduced themselves, the only professed farmer in the room stood up and said he wanted to have the tools and knowledge to test his own tile. Other farmers had told me about having their tile sampled for their own curiosity, but generally they were embedded in watershed monitoring projects (Figure 6.8). This farmer wanted to have tools for himself, which stuck with me.

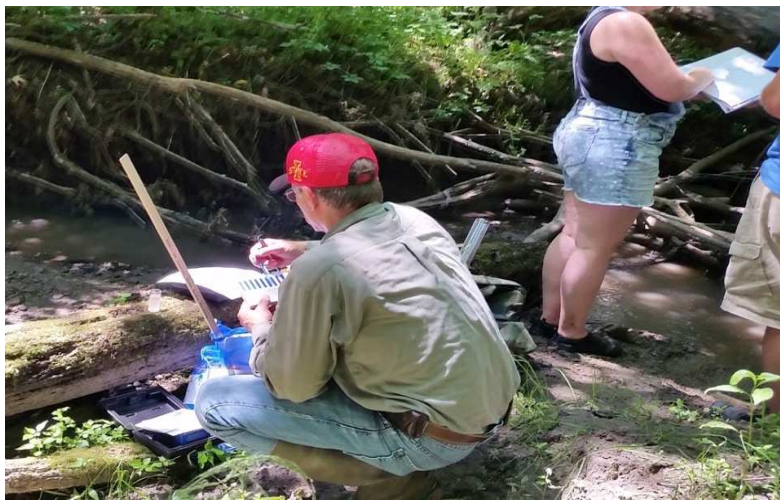


Figure 6.8 Farmer checking the dissolved oxygen in a creek during a training

In contrast to citizen science projects, sensor projects like the IIHR's²⁷ Iowa Water Quality Information System (IWQIS) also provided water quality data, every fifteen minutes, whenever the sensors were in the water. Sensors cost about \$35,000 and were

²⁷ Engineering school at University of Iowa

too sensitive to remain in the waterways²⁸ during the coldest part of the year (Figure 6.9). They were taken out around November and returned in the spring after the thaw. This project uses sensors installed by IIHR and the USGS (United States Geological Service) that collect data on nutrients, flow rates, and water temperatures. A separate but related system, the Iowa Flood Information System, was also through the broader WIS (Water Information System) project. At the time of my fieldwork, there were 41 water quality sensors in operation, 15 from the USGS and 26 from the Iowa Flood Center. The goal was to have between 50 and 60 total running in 2016.



Figure 6.9 Water quality sensor station in Sac County, IA

Once I learned of the IWQIS, I looked every day, to get a sense of what the conditions of water were, especially nitrate/nitrite (Figure 6.10). Clicking on a circle would bring up a world of data, a pale blue circle rippling out from the circle and outlining the watershed. The different colored circles have a key in the left-hand corner, with dark red meaning over 20 mg/l; red 15-20 mg/l; orange 10-15 mg/l; yellow 5-10 mg/l; and green less than 5 mg/l. 10 mg/l was the federal drinking water standard, and

²⁸ Sensors in drinking water infrastructure could stay in year round, however.

recent research showed that above 2 to 4 mg/l has been correlated with increased risk for certain kinds of cancer, as discussed in Chapter 5.

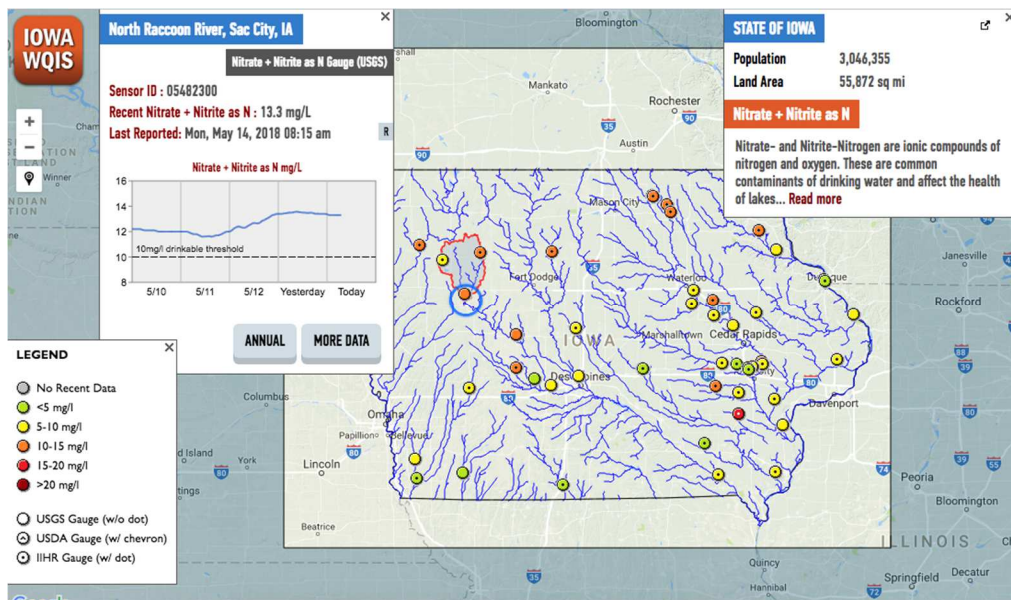


Figure 6.10 Screenshot of water quality information system data on May 14, 2018.

On May 14, 2018, the North Raccoon River near Sac City had 13.3 mg/l of nitrate, highlighted by an orange circle. In contrast, Miller Creek in LaPorte City, in the Middle Cedar watershed (known as the collaborative one), had 7.8 mg/l, earning it a yellow dot. A point in time is not as useful as the trend over time (Figure 6.11). During January through June, a critical period of bare ground and planting crops, nitrate levels in the North Raccoon River near Sac City stayed consistently above the 10 ppm standard, hovering between 12 and 16 ppm except for a slight dip in mid February. The Miller Creek sensor was not installed and recording data until late April, where it also ranged between 12 and 16 ppm.



Figure 6.11 Comparison of trends in nitrate levels in the North Raccoon River (top) and Miller Creek (bottom) during January through June 2016 (Screenshot from IWQIS).

The website gives a background on nitrate, explaining its origins, its nature, and its consequences as well as real-time and archival data about the conditions of the water since 2014. I do not have a sense how many people used or even knew about this tool, or

the extent of its use. However, I was told that groups like the Farm Bureau opposed the IWQIS when it first became operational. The placing of sensors often had political implications, and the Farm Bureau had threatened to have the whole water quality system shut down. They framed the monitoring as encouraging a “we have a problem” instead of “we have a solution” network. However, many of the people I spoke to were curious about water quality data, on their land and in their watersheds, particularly if there were conservation practices that could impact water quality. The IWQIS system had plans for testing of wetlands and other practices to measure the impact of conservation.

Water quality monitoring could cultivate embodied knowledge and provide a baseline for what was happening on the Iowan landscape. It filled in one of the gaps articulated by the prairie assemblage’s deterritorializing critiques of the NRS.

6.3 Technological Land Epistemologies

During our interview, John and Will, a father and son farming operation, displayed one of their field’s soil map, a Technicolor swirling wave, explaining that even in one field, they had multiple different soil types. They described a system where Pioneer gave them a weather station, they reported their nitrogen program, and based on the soil and yield history maps, recommended how much nitrogen to apply. This variable rate program meant to direct farmers in applying only as much fertilizer as corn needed to reach maximum yields. This included a moment where farmers must decide whether or not to trust the technology, the calculations for nitrogen volatilization, or not. As John said,

We got the prescriptions back—some of that wasn’t calling for any nitrogen, right, Will? □[sigh] That’s kind of blind trust. [sigh] Last thing you want to do is starve it of nitrogen...right around mid-July when it’s too late to do anything. I’ve had fields like that over my 30 years for fields that call for no or little [nitrogen]. With these monitors we will be able to see how accurate they were.

That map showed me that technology did not necessarily mean people were isolated from their land. It created a different kind of knowledge, one where soil types, fertilizer amounts, and yields were combined on a single map, a multiplicity, giving farmers an idea about what was happening in the field, and this made them feel close to their land.

It was this technological land epistemology that many different groups were pursuing for conservation. Increasingly, this meant embedding conservation into precision ag technology like what John and Will described, and turning to ag retailers²⁹ (input dealers and grain buyers) to provide conservation as part of their services to farmers. One conservation expert, Smith, had transitioned from the governmental to the private sector. He discussed the software available that did the work of NRCS sixty times faster and more accurately. The maps that John and Will described to me, with conservation software, could also include a layer showing soil erosion. These layered maps could demonstrate how soil loss affected yields, and with increases in soil erosion, this could encourage more efforts to keep it in one place. Smith advocated for built structures like Eric since practices like cover crops or no till were not permanent. Still, these maps could promote soil health practices as well.

During my fieldwork, AgSolver was the software generating the most excitement in the conservation world. The premise of the small company's software was that three percent to fifteen percent of any given farm field was not productive. No matter what you put on it, it was never going to give financial return, and it cost the farmer money. AgSolver's software targeted land to take out of production. Many conservation people

²⁹ Similar modeling software was also developed at universities, within government agencies, and NGOs; however, there was a significant intersection between this software and the private sector in many of my conversations.

thought this would have a public benefit of getting wildlife and pollinator habitat.

However, several people, such as Smith, put the issue with AgSolver to me like this,

AgSolver's got a great package...[but] farmers are not going to set aside land. They're gonna figure out how to change that land to produce more off of it...not gonna set them aside. [If it was me] I'm gonna figure out what's wrong with them. It [AgSolver] plays well in the conservation community. I don't think it will [in practice]. Tell me I'm losing 100 dollars an acre. Now I know I need to go tile that land...they don't set aside land. They figure out how to make it better.

So while a soil erosion map overlay or software showing unproductive acres could result in conservation strategies, other options such as increased fertilizer applications or drainage tile installation were also options, likely more familiar to many farmers.

Additionally, Smith framed the relationship between ag retailers and their farmer customers as hesitant in discussing conservation.

Ag retailers are uncomfortable with conservation because it is new, and it is complicated as you and I talked about. We're developing these lead-in conversation starters. Ag retailers are real good with their soil maps or yield maps...with a layer of soil erosion...as they're going through their deck of maps with farmers, they can say, Oh, look, 'I see you have some potential for soil erosion. Do you want to talk about that?' 'No'... 'Yes.' 'Okay, let's talk about this.' It's a conversation starter about soil erosion and where it's occurring on their farm.

In addition to being new, discussing conservation also positioned people in a particular way. Nathan, the conservation expert from Chapter 4, confirmed this hesitancy when I asked if he discussed water quality issues with his clients. He said he and his clients acknowledged different politics between them, but they were still able to trust each other for the work he did for them. Nevertheless, he did not bring it up and was cautious when it was part of the conversation. These were business relationships, he explained. He often had to live with a certain amount of cognitive dissonance between his own values and his work. Environmental issues would often label someone as a liberal and usually

suspicious for farmers who did not trust or like the government. With me as well, being interested in conservation made me suspect from the beginning with many of the farmers and conservation experts I spoke to. I adopted a cool intellectual approach, one that I learned was required to be less suspicious for them. While for me science was tangled up in emotions and politics (and I witnessed that in all my conversations), they expected a detached affect from me, even if they became visibly angry or frustrated.

I was also uncertain how conservation fit into ag retailers' profit goals. There were so many ways conservation did not seem conducive to the way the current agricultural system generated profit: taking land out of production, using ecological systems rather than chemistry, physics, or genetics for solutions. I thought about Wes Jackson, the Land Institute, and their efforts to develop perennial crops (Jackson 1999). How could a system based in annual crop agriculture possibly desire perennial crops? It seemed unlikely, and again I thought of geographers Roberts and Lighthall's (1991) recommendation to fund research outside of the control of the agribusiness.

While many thought technology would be the way for conservation to be relevant for agriculture and indeed farmers mentioned with wonder the technological changes they had witnessed in their lifetime, it also had its drawbacks. Even though mechanized agricultural equipment was a given, computerized equipment left some farmers uncertain (Figure 6.12). I spoke to farmers and several equipment dealers who discussed how computer technology shifted knowledge away from farmers. Messing with the computer system on a piece of equipment could result in problems with the company that sold it. Steven, a North Raccoon watershed farmer, told me he did all the equipment work in his farming operation with his brother but he was "out of the loop" on computer technology.

That put them at the beck and call of the dealership, he said. I asked if he could still do mechanical repairs, and he gave me the example of his friend's new semi, where complex air and hydraulics systems did what a simple mechanical system has done in the past.

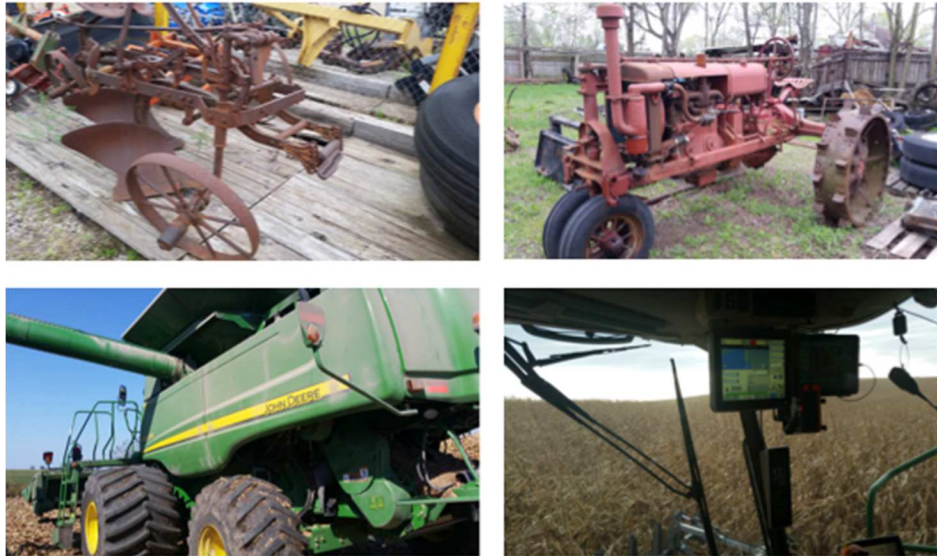


Figure 6.12 Evolution of mechanized, computerized farm equipment

It's more complicated but also more operator friendly. He liked to operate equipment, not just drive it. But he admitted in the fall harvest when he was tired, he could imagine less stress and more efficiency in the computerized models. It seemed there was a trade-off in terms of knowledge, replacing one mechanical kind with a more informatics, computerized version. In the final section, I discuss the implications for assemblage desires and the conservation boundary object in terms of the strategies.

6.4 Concluding Remarks

In terms of soil health, water monitoring, and technological land epistemologies, what did they do for each assemblage's desires, their bridging, and the conservation boundary object? Soil health could address both desires and shifted the infrastructure of the conservation boundary to a long-term perspective and liveliness. Water monitoring addressed neither desire directly, but it could add infrastructure to the conservation

boundary object. Finally, technological land epistemologies were ambivalent; they could promote either, both, or neither of the assemblage's desires, and they were similarly uncertain for conservation. The goal then was to bring local definitions of conservation into closer alignment, even co-production, through the merging of assemblage desires. Consensus was still not required, but it could make what had been a difficult task more manageable and achievable.

Farm continuity and land revitalization could be pursued as the same end goal. However, the infrastructure of the corn and soybean agriculture system overall did not promote this. Farm continuity was the only desire that can be addressed partially in industrial agriculture, and as research has shown, this system privileged high capital investment and surplus production rather than livelihoods (Barlett 1993; Bell 2004; Durrenberger and Thu 1996; Goldschmidt 1978; Magdoff et al. 2000; Ramírez-Ferrero 2005; Thu and Durrenberger 1998). Many people lamented to me they did not know how to help farmers focus on long-term goals rather than the short-term annual cycle of fluctuating prices and harvests.

Soil health was one strategy, proposed mainly by the prairie assemblage, to do so. It achieved land revitalization by promoting liveliness in the soil that could deal with water and nutrients. Similarly, promoting healthy soils would allow farming operations to continue by restoring and rebuilding lost soil and lost fertility. However, the calculations of land value in Iowa do not support these practices or soil health tenets. Additionally, in Chapter 3, I explained the conundrum of land ownership and renting. Without some certainty that soil health promoting practices on rented land will benefit a farmer's operations and successors, it seemed unlikely soil health would have as much impact

outside of land ownership. Even for the prairie assemblage, cover crops and no till also were subject to the corn and soybean system, specifically corn. Few farmers achieved no till corn, although I met quite a few who did strip or vertical till, which limited the tillage to directly where the corn would be planted. Cover crops were terminated before corn was planted, which meant nitrates were still lost during the gap between the cover crops and the corn's full-fledged use of the nutrients. As for the conservation boundary object, soil health brought its infrastructure into focus, promoting changes in practices from farmers that would help the longevity of the soil and the farm. Throughout my time in Iowa, conservation was generally approached as a toolbox strategy (i.e. the NRS) and on a "first come, first serve" basis. The success was in putting conservation practices "on the ground," rather than considering what they were doing or where they would serve the most good. Soil health was a potential equalizer, saying that every acre should have cover and be disturbed as little as possible.

Water monitoring also mainly came from the prairie assemblage. This had to do with the desire to know what had been happening on the landscape in a quantifiable way, giving a foundation to revitalization efforts. It could address the limits of the NRS. Still, water monitoring itself did not address the prairie desire for land revitalization, but rather aided it. Similarly, water monitoring would not help the continuity of the farm. However, the corn assemblage could use results from water monitoring to show success (or not), and use this in negotiations around potential regulation. Even more, the corn assemblage, with the NRS-lawsuit events, was beginning to question tile as an active entity. How was it contributing to nitrate pollution? While farmers would laughingly tell me they had drunk from tile lines and they felt fine, others framed it as a problem. Water monitoring

would add infrastructure to the conservation boundary object by providing baseline information, which could help measure success for conservation goals and practices.

Finally, technological land epistemologies were uncertain in the context of conservation. It expanded the innovations of precision ag into questions of conservation. As I discussed, these software programs could help a farmer know his land, but what he decided to do with this knowledge could lead him toward or away from the conservation boundary object, as well as the assemblage desires. For farm continuity, staying up-to-date with the latest shifts in agriculture was often seen as being innovative and efficient. Without a computer background, farmers could not do maintenance of their equipment themselves, and with a short supply of computer specialized mechanics, this could affect their ability to do the work of farming at critical times. However, even more troubling, some people felt too much technological advancement hurt the future of farming. Specifically, technology that made it easier to farm was seen as problematic, letting farmers continue into their 70s and 80s, while their sons and grandsons had to wait to inherit the full control of the operations, limiting their opportunities to gain experience and experiment. For prairie assemblage desires, whether software would suggest land revitalizing practices (e.g. cover crops, reducing tillage, taking land out of production) or status quo practices (e.g. fertilizer applications, tiling) was debatable. I did not see statistics about how many farmers who used a program like AgSolver picked one strategy over another, but there was strong ambivalence about the outcome of such a strategy.

All of these strategies have potential to merge the corn and prairie assemblages and strengthen the conservation boundary object's infrastructure and labors. Bridging strategies like soil health had the most ability to move the assemblages together. Filling

in the gap strategies like water monitoring could also create common goals in the desire and baseline information for conservation. Expansion through technological land epistemologies had the least potential to radically shift assemblages or boundary objects, although due to its relative ambivalence in applications. Despite the potential of these bridging strategies, they all faced similar issues, specifically connecting with farmers. Many people suggested farmers needed more information or evidence. However, I found it was not that knowledge was lacking but that knowledge lacked transformative potential, particularly in its current methods of circulation and delivery.

Soil health as a topic circulated widely through field days, conferences, and meetings at the time of my fieldwork. However, my overall impression of field days was that they were poorly attended by local farmers. At the first field day I went to in southwest Iowa, I sat with three older hilarious farmers. One of them, Scoop, leaned over to me and said, “I came because I knew the Cattlemen were cooking. It’s always a good meal when they’re here.” Most field days provided free lunch, either from the Pork Producers or the Cattleman’s Association, and were treated somewhat as social events, with plenty of fodder for gossip and storytelling. Farmers suggested they came out of boredom, curiosity, and/or solidarity with conservation goals—a wide range of emotional motivations to cater to. For example, at a specifically billed “soil health field day” organized at a local park, only four or five farmers were in attendance out of roughly thirty people, and all of them worked with the local NRCS office regularly to put in conservation practices and had served as SWCD commissioners at different times. Field days located either on farms³⁰ with conservation practices to show or with well-known

³⁰ This was a strategy of Practical Farmers of Iowa (PFI) (see Bell’s 2004 ethnography).

public figures (e.g. the governor, state Secretary of Agriculture, well-known farmers or researchers) speaking seemed to attract slightly more farmers, but attendance was overall low. Conservation experts also needed this information, but if the goal was to introduce farmers to different conservation practices, they simply were not in attendance at field days for this process to begin.

Throughout my interviewing, though, I found information was not the main issue. Overall, farmers believed they had enough or even too much information to manage as agriculture had been transitioning from manual labor to mental and information-processing labor. As I mentioned before, information fatigue was real. In fourteen interviews where I asked about information (e.g. if farmers wanted more information, where they got information from), eight of the farmers mentioned they had enough information or they were doing all they could for their operations. Here are several excerpts (presented simultaneously) from interviews demonstrating this overall feeling of information saturation:

Bri: Are there practices you'd be interested in having more information about?

Corey: We're pretty much doing everything we can. Maybe we could do a little more with no till. We no till beans. Corn is scarier.

Bri: Which outreach tools have been the most useful for you?

Gus: I guess I would've said field days when I was younger. But you get older and you think it you know it all. And you don't want to change. I don't no till. I see that it works. No till equipment is so expensive, though, and one year something might be popular, but in the next five years they have something different. I think the machinery companies do it that way on purpose.

Bri: Are there practices you'd be interested in having more information about?

Harvey: No, there's not a lack of information. It's more sifting through it to find the pertinent stuff. When you surf the Internet, those ads are using your neurons. You register a thought for that ad. It's garbage. Diluting what's important.

Two farmers told me that NRCS and watershed projects should get more information out there, but neither suggested they personally needed more information. One of these farmers echoed Corey, saying he wanted to know what else he could do. The other farmer wanted information but with further questioning, he wanted to develop a relationship with NRCS to receive information specific to his farm. Rarely did these farmers suggest they needed more abstract knowledge about conservation practices, like cover crops. They wanted local information from neighbors, other farmers, and sometimes conservation experts about what had worked, and how.

Water monitoring may have had more resonance with farmers since they could test their tile lines³¹ through watershed projects or through programs provided by producer associations like Iowa Soybean. A conservation expert told me the story of a well-known farmer who believed he was doing everything he could, saw his tile line nitrate numbers from water monitoring results, and changed his practices drastically. However, several farmers mentioned their results to me, with some trepidation, and would say they did not know what to do about it since they were doing everything they could already. The well-known farmer was exceptional in his case then. Similarly, as Smith discussed, farmers were interested in precision ag technology applied to conservation. However, this information still had to serve questions of yield and profit and could result in a range of results, not simply conservation practices.

It is dependent on these strategies' future communicable cartographies, their interactions with politics, and their cultural salience whether they will be able to push conservation to the fore and therefore shift the industrial agricultural system to farm and

³¹ Having tile lines tested rather than doing the tests themselves in citizen science projects seemed more common among most farmers I spoke with.

landscape conservation. These strategies relied on knowledge having transformative potential, but in this chapter, I have discussed both the successes and failures, and simply ambivalent effect of relying on knowledge infrastructure to produce behavioral and practical changes. There was hope in meeting farmers “where they are at,” but there was also the silent majority of farmers that the conservation world was not reaching. In the conclusion, I reflect on other ways to fill the gaps in the conservation boundary object that the assemblages have come up with in the face of loss across the corn and the prairie assemblage.

CHAPTER 7

PRAIRIE SMOKE AND AGRICULTURAL ALCHEMY

“All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. The land ethic simply enlarges the boundaries of the community to include soils, waters, plants and animals, or collectively the land.”

- Aldo Leopold, “The Land Ethic,” A Sand County Almanac

Alan drove us around into the encroaching dark. We went around the quarter section including his farm, and he pointed rhythmically to me, “There used to be a family,” a stretch of bumpy road and then, “and another family there. A beautiful farmhouse stood there.” There was corn and a small grassy lot. Many houses were gone, and he and one other farmer were the only two left farming in two square miles, even though other farmers called Alan a hobby farmer since he farmed less than two thousand acres. Absentee landowners owned and rented out the other land, and town folks lived in the other houses. They did not farm but, Alan mused, perhaps wanted to live in the country. Here, he recollected, was where a neighbor’s land literally had come off his field and filled in ditches and cut through the road, black soil fanning across and piling up along the edges. At the far corner, he recalled the country school he attended for six years with the rest of the kids from the surrounding farmsteads.

Heading back home, we stopped on the edge of a berm overlooking his CRP prairie. His son and son’s friend had shot 10 and 12-point bucks. Crowds of pheasants flew from it. Alan’s kids did not want to come back and farm the land. They had lives and jobs in other states. Alan was a bachelor now, and one of five kids. His oldest sister

had two grandsons who farmed near him, and it sounded like perhaps they would take over the farm. He sounded uncertain. When we had been out together another time, we stopped for lunch, and I told him he did not have to pay for me. He said softly, almost to himself, “I would for my daughter.” He seemed a bit lonely and alienated, from his family, from the community, perhaps for his odd views or the lack of community, or both. Throughout our interview, he had told me, “Thank you, thank you so much for this opportunity,” and I was baffled that anyone would consider talking to a green scholar anything but a generous favor to me.

Gazing at the scene from his dirty truck windshields, he said he loved looking over the prairie (Figure 7.1). I could see why. It hummed with insects. The wind rustled its grass. The CRP had three more years of an extended contract, bumped from ten to fifteen years, and then he would put it in continuous corn when the time came. I was startled but kept it to myself. In my notes, I wrote that I had trouble understanding CRP. You built this prairie, and then after a decade, you could put it back into commodity crops. Was it just for fallowing? Did the program hope to inspire love for the CRP, for the wildlife seen there? This was from a small-scale farmer who survived the farm crisis, who used old machinery and no till, who had a history of conservation in his family, and seemed to live modestly.

Alan’s farm would not continue with his children, and this prairie that had given him joy would not continue, becoming corn for season after season. I felt the compounding loss. No aspect of the boundary object seemed to be succeeding. Still, Alan drove us around his watershed to show me all the conservation projects happening. He took me on this drive when I had said, after a plane ride above the county, that I had not

seen much conservation from up there, the landscape dominated by dark tilled fields and hog confinements. While I may have not seen conservation, for him or from above, Alan did. His care for his land and the land as a whole seemed apparent. Why then was he putting a fifteen year-old prairie back into continuous corn? While Alan wished to show me the hope, in this moment I felt overwhelmed by loss.



Figure 7.1 Alan's CRP prairie

Soil loss, nitrogen loss, loss of prairie, loss of wetlands, habitat loss, loss of small grains and perennials—these have been some of the losses reverberating across the Iowa landscape. “Black snow” appeared in the winter, where tillage had made the soil so fragile it left with the snow drifts. Fencerows along the edges of fields, which still retained the high organic matter of the prairie, were tilled into cornfields during high corn price years. Restored prairie and wetlands could not compare to native ones in terms of diversity or function.

The loss echoed in the social fabric as well. The farm crisis had bankrupted many

farmers. Neighbors used to help bale each other's hay, but with the compounding loss of outdoors livestock and neighbors, that had gone away. There were more pigs than people in many counties in Iowa. Young people could not farm. Young people did not want to stay in Iowa. These were some of the stories of loss I collected throughout my fieldwork. So Alan's story, not uncommon, showed a multiplicity coalescing around losses of social and ecological liveliness. This multiplicity of loss was the emotional foundation of the corn assemblage and the prairie assemblage, and the work going into the conservation boundary object.

What was at the center of all this loss? Although this dissertation focuses on the complexity present in Iowa, the answer seemed simple enough: corn (Figure 7.2). This answer is well documented in Iowa. There has been decades of research on introducing perennials and other crops back into the alternation between corn and soybeans (e.g. Liebman and Dyck 1993; Liebman et al. 2013). Pollan (2006) described corn's ingenious takeover of the agricultural landscape and food system, specifically in its allure in a co-domesticating relationship between people and corn.

I mulled over the quote from Chapter 1, "...this is corn without qualities...Such corn is not something to feel reverent or even sentimental about, and nobody in Iowa...does" (2006: 59). However, corn is a multiplicity, and the human actors helping it grow are not devoid of sentiment for the crop. Corn is entangled in other relationship and contexts facilitating its position of power, which have all required immense labor over time and space to maintain. My conversation with one of the wealthiest farmers in Iowa, Arthur, demonstrates both the naturalization and unveiling of the labor going into corn.



Figure 7.2 Corn

We sat in Arthur's office, a large desk in-between us. I asked him about the politics of the situation around water quality. What follows is my paraphrasing of our conversation. He replied,

I couldn't care less about your water system, but I don't want to lose those nutrients going into the water. The problem is we don't have enough information. I want to minimize the loss of dollars. But Mother Nature is hard to predict. There are things we can do to improve water quality, but we will never get it down to zero, it [nitrate levels] will never not be elevated sometimes.

He used several classic tropes and rhetorical strategies discussed throughout this dissertation. "Mother Nature," lack of information, nutrient loss over water degradation, Arthur summoned all of these to discuss the "natural" state of nitrate loss. He then went on to discuss capitalism and Iowa's ecology as "natural systems."

The capitalist economy is excellent at allocating resources and meeting supply and demand. It will work out what needs to happen. Bureaucrats get in the way. I'm not saying capitalism is always correct but it returns to balance things and people manage to mess it up. If we let it operate more or less freely since it is not operating that way now and we do need some rules and regulations, which I think are good...

I asked him, was this really the best system of agriculture in Iowa? He confirmed it was, telling me,

Now I get a radish from California. Why do I get that radish from California? Efficiency always wins. It always wins. Growing that radish in California was done in the most efficient manner possible despite the freight cost.

This local grown food. [scoffs] I want the best and cheapest food. First of all, good, second, cheap. Or maybe that's not the right word—cost effective.

Well I'm growing 800 acres of an herb. The oils in it are not well understood...it is antimicrobial, antibacterial. Now you've probably heard that they're phasing antibiotics out of livestock feed. Well this is an antibiotic but it's okay because it's "natural." It has the same result...So people think oregano is a spice. Not so. There are people who thought it didn't taste good, and they're dead. The people who think it does taste good are alive. The same with this herb. Ruminants also can like or dislike this and digest it. It isn't good or bad, their DNA tells them whether it is good or bad...

The economy will take care of it. There is a reason corn and beans grow here and not rutabaga, cotton, wheat, flax. You don't see those things because corn and beans grow best here.

In these excerpts, Arthur naturalizes Iowa's ability to grow corn, certain people and animals' ability to survive based on their genetics, and capitalism's ability to grow the best radish, corn, etc. Many people told me that Iowa was meant to grow corn, although several people also told me that Iowa used to be a top exporter of apples and tomatoes. This corn destiny generally seemed rooted in the fact that Iowa's rich, black soils had high fertility, to which corn responded well. Yet I thought of all the tillage required, and the pesticides, fertilizers, and other inputs, as well as the all the work of creating hybrid seeds—the manipulation of genes in the lab and the growing out of seed corn for years—and wondered, is this truly the agriculture's fate brought about by natural forces? It seemed like the destiny of Iowa soils required a lot of capital investment to succeed. Arthur addressed this as well:

There used to be surpluses...Because they were government mandating and controlling prices...

These merger cases [Monsanto and Bayer], they tell the Justice Department, 'Oh, no, we're not going to bundle seeds and chemicals. We're going to produce better products. And they will [bundle]. They couldn't care less...well I shouldn't say they couldn't care less.

But Monsanto acquired Asgrow. DeKalb. Other companies. They didn't do any of it. Any of the work. People say you need the big companies for innovation, but that's not true. They buy and raise the prices...These big companies, it's about maximizing profits.

Arthur told a selective history. The government had dealt with surpluses in the past, but the surpluses remained today. Corn surpluses explained lobbying efforts for trade deals with foreign countries as well as market expansion, into ethanol and other corn products. His summary surprised me because he did acknowledge the role of agribusiness, particularly that they were not sources of innovation. He did not seem to connect them to his earlier comments on efficient Californian radishes.

Corn is unique as an American commodity in a number of ways. So far it has not been directly linked to causing a human health problem, like tobacco and lung cancer (although attempts have been made through critiques of the health effects of high fructose corn syrup and grain-fed meat). Even with the health problems associated with tobacco, the tobacco companies encouraged American tobacco farmers to blame the state and public health movements against tobacco rather than examine the corporate transition to cheaper foreign-grown tobacco (Benson 2011; Kingsolver 2011). The moral discourse (corporately supported) was for people to take individual responsibility for their health, rather than see the systemic failures and neoliberal market logics encouraging free trade. Tobacco farmers would draw on the paradox of providing for their own livelihoods but also creating a lethal product (Kingsolver 2011). Additionally, these farmers were frustrated the same moral boundaries were not in place for producers of alcohol or suppliers of marijuana. Even with federal restrictions and clear health consequences, tobacco farmers found ways to justify growing the commodity, with logics echoed by the corn and bean farmers I talked to. Their blame and frustration went to the public and the federal government, not large corporate agribusiness and their search for the most cheaply produced tobacco abroad.

Corn yield-profit overrode the conservation potential of soil health and technological land epistemologies. It weakened the infrastructure of the NRS to be flexible and subservient, rather than hierarchal and measurable. It transformed nitrate research that revealed the corn agricultural system as the problem into an ally, blaming natural ecologies like soil and prairie instead. Corn, as part of privatized profit, has been allowed to degrade the commons, that of water. Even when trying to improve water

pollution, most of the solutions came back to the soil and the land. The pursuit for corn distracted from what all people needed to survive: water (Figure 7.3).



Figure 7.3 Measuring the transparency of the Raccoon River

Corn swayed politics toward its survival, created rigid economies, and trumped ecological stewardship for other vital ecologies. Overall, there is no public reckoning with corn's damaging effects on the future of the Iowa landscape as a whole. Instead, corn is naturalized, reified, and unassailable. Corn is the ultimate player in reterritorialization of Iowa, for the benefit of corporate and political interests and embedded in the cultural identity of Iowa. However, the corn system has points of weakness, as evident in issues such as weed resistance and continually low grain prices. All the labor I have discussed at length does not have to continue to support its primacy on the landscape. I saw moments of escape and hope for land revitalization and farm continuity that, from the perspectives of some of my participants and myself, challenged the current system. Sometimes there were examples of these challenges happening on the

landscape, in practice and discourse, and sometimes they were limited to the realm of dystopian and utopian fantasies.

7.1 Fantasy Scapes

Part of my research investigated the fantasy scapes of Iowa. In fact, I came to Iowa because of a fantastical claim, that cover crops in Midwest could reverse the dead zone in the Gulf. When I arrived, I wanted to know what people imagined for the landscape of Iowa, both their desires and their predictions. Soon, with all the driving time, I daydreamed about what the landscape could look like, wild imaginings of Iowa turning into a swamp and former farmers heavy with nostalgia and regret as they eked a living out. Or the creation of an ear of corn that could feed a person for days with all the nutrition packed into it. Or a small and versatile machine, inexpensively produced that could do dozens of tasks, and run off the power of local solar and wind farms. Or perennial crops that were productive year after year, and always kept the ground covered and rooted (visit The Land Institute's website to see a research group working on this very dream). The miles of flat and rolling cornfields, and the enormous expanse of sky, all seemed to encourage these speculations. The DMWW lawsuit also invited speculations, particularly as people navigated a potential regulatory future. Clint, for example, summoned a totalitarian future for public shaming and conservation compliance (Chapter 4). Others considered more grounded possibilities, like a water quality conservation plan or a fertilizer cap, which had precedents in other states. The fantasy I encountered the most, however, was a world without federal support for farming.

I asked farmers, "Should there be environmental accountability since farmers receive taxpayer dollars?" This elicited a variety of responses, but often, farmers would sigh, telling me they wish the government was not involved in providing cost-share for

conservation and that they wish agriculture could pay for itself. Two young farmers in their late 20s emphasized that this was their preference, a world without taxpayer support of agriculture.

I wish it would go away. I don't mind a little bit of regulation. Why are we [taxpayers] paying for it [conservation/agriculture]? Without government programs, it would sort itself out...I also like to have the roads, etc... [but] government programs go back to landowner. I rent most of my land so I know where money goes. Just take them away, and that's fine.

- Casey, row-crop farmer

Most farmers [would] prefer if they got rid of that altogether. I don't want a direct payment - get rid of it...as far as that goes I'd be a fan of getting rid of all of it together. Let the business stand as it used to...put it on level playing field. But that's not going to happen.

- Caleb, row-crop farmer

What would a world without subsidized agriculture look like? We could look to other countries dealing with structural adjustment loans that prohibit subsidizing local agriculture at anything but the lowest rates, if at all. Yet farmers generally did not entertain the fantasy this far, rather focusing on their present desire for this to happen and that capitalism, like Arthur suggested, would take its course. It was unclear to me if they saw themselves as surviving such a drastic change to the system. However, despite these fantasies, both of the farmers quoted above received government financial support, as did most farmers. Rather than stop federal subsidies, Joe, a conservation expert, suggested, "We should thank farmers for providing an abundant and affordable supply of calories, which is what people wanted [in the past]. We've never had a famine in this country, and we've been through two world wars...now we're asking for something different. We're asking for an environmentally friendly and sustainable practice."

Fantasy scapes came without my prompting throughout my fieldwork as well. At a conference entitled "Could Flint Happen Here?" held by University of Iowa Public

Policy Center and the Center for Health Effects of Environmental Contamination (CHEEC), Dr. Peter Gleick, a hydroclimatologist from California, welcomed us to a conference set in 2116. In the 22nd century, he imagined for us that we had created sustainable water systems by paying attention to our natural environment. We had restored fisheries and wetlands as well as peace to conflict zones like Syria, where water was scarce and precious. He still summoned the effects of climate change. All mountain glaciers were gone Miami had had a massive resettlement. Archaeological research speculated that plastic bottle waste was carbon sequestration. Even Iowans migrated to Canada due to flooding for two months out of the year. Gleick addressed agriculture directly:

People used to have grass they would call lawns, a remnant of an English past. Water delivery used to be for the rich, the poor would get intermittent water or nothing. And farmers would pay nothing for the water they used. We now have technology that is more crop per drop. Nonpoint source pollution has been tackled. And we've curbed unsustainable groundwater use. Now we don't use land that could grow a food crop for fuel as part of the antiquated gas machinery...

Here he implicates both urban and rural landscapes in poor water use and treatment, a remnant of being “all in this together.” Yet radical change had happened through collaboration. He imagined this world was possible through a reconceptualization of water use, where water was deeply valued. Once we had dried up the Colorado River and needed space exploration for more water, we had finally started reusing wastewater and desalination, and overall, finding the true price and value for water.

Another realm for fantasy scapes was the prairie (Figure 7.4). This fantasizing looked to the past for its inspiration, rather than the futures of the hydroclimatologist or my windshield daydreams. The prairie needed demystifying too, as several farmers told

me they used to kill milkweed as a pest and now they were “growing these flowers for butterflies.” At one conference focused on ecologies and conservation, Dr. Thomas Rosburg gave the audience lessons we could learn from the prairie: embracing diversity, planting deep roots, being efficient and frugal. These lessons translated to more than the physical landscape. They were about social values as well. This meant embracing the increasing ethnic diversity of Iowa, specifically the 5.8% of Latino people in Iowa, many working in places like Storm Lake and Postville for agricultural/livestock processing, into a predominately white state (91.4%) (US Census Bureau 2018). His lessons meant committing to Iowa as a home, and they called for a reduction in consumption. He advocated for the prairie model of being adapted for a sustainable agriculture, similar to Jackson’s (1991) natural systems agriculture. Dr. Lisa Schulte-Moore asked the audience a similar question: “What makes prairie effective?” People gave her answers: deep roots, diversity, perennials, habitat. It was supposed to be there, people said. She agreed, adding, “With diversity, something will always do well.”



Figure 7.4 Prairie in full bloom (Photo credit: Suzan Erem).

I would add one final lesson I learned from the prairie during my time in Iowa. Sometimes, in order to grow, something must burn first. Prairie and its biodiversity thrived with the aid of fire, ashes providing some of the best sustenance to start over. Talking to and working with Iowans, it sometimes felt that we were headed toward the fire or its aftermath, and all we could see was the smoke.

7.2 Hope on the Ground

I found hope in the gaps of corn industrial agriculture, things it could not control for or predict, things it even could facilitate with its inability to reach and connect. The two main areas that gave me hope were cover crop businesses and shifting land values. Several farmers discussed growing their own cover crops on their land and becoming adept at planting them on neighbors' land (see Chapter 3 and Figure 3.16). Strategies such as this could help develop cover crop seeds adapted to the Iowa landscape, and it encouraged farmers to integrate conservation into their own operations as part of their business model. Additionally, several public figures (the ISA president, a state legislator) as well as several farmers discussed incorporating conservation into land values and tax infrastructure. Why should CSR determine the value of the land? Why shouldn't no till, cover crops, and low levels of pollutants in the water also play a role in setting value? When people connected the social and ecological interdependence of the land, I found hope (for an example, see Durrenberger 2018 on SILT, the Sustainable Iowa Land Trust).

I found hope in the connections between slowness and liveliness. This appeared, for example, in the form of a professor holding a "mussels petting zoo," where a crowd marveled and touched animals, with wild and lovely names, that are basically rocks. These mussels, if the water slowed down (through the help of oxbows and wetlands), could thrive again and clean water. It appeared in cover crops growing a foot tall, being

knocked over into a mat of grass, and having soybeans planted right into them (Figure 3.21). I found hope in attitudes like Casey's (see Chapter 4), that he would simply be ready for regulation or bad weather, with his conservation practices, and Robert's, where he believed farmers must do better. I found hope in digging in the soil with pasture and cover crops and seeing it alive with roots and insects, its loamy smell heady. I also would have found hope in efforts to hold agribusiness to account, insisting that since they had benefited most profoundly from this system, it was on them to support radical change to the system. However, as Roberts and Lighthall (1991) show, profit was the agribusiness goal in research and product development, and even the pushes for sustainability from and for these corporations did not challenge the system.

7.3 Why Iowa?

I have been driven to do this work because I believed we were missing something. I wanted to explore industrial environmental relationships and find embodied knowledge that came from knowing the land, despite and even because of the technological innovations. As good research often does, my initial questions led me to entirely different ones, to which I have only partial answers. What I found was not new knowledge, but rather quite old. I hoped that, by framing what I learned in a relational way, allowing for an examination of complexity and power within these relationships, I could reveal what often gets naturalized and mystified: the sociocultural systems we live in require a lot of ideological and material labor, which means there are always gaps to exploit for change. As I learned in Iowa, abstract principles like "the soil must have active roots" are important foundations, but we must always ask, how does this work on the land? We cannot assume that even as systems attempt to standardize and homogenize, as industrial agriculture often does, that they work in the same way everywhere. How has monoculture

worked in Iowa? How has mechanization and technologization? What allowed for the rise of large-scale operations? How have conservation efforts affected this system? How did people live within this system, with pride, nostalgia, regret, and hope all messily entangled?

In Iowa, the life force for the global corn system, the particularities of the land, history, and politics have created a peculiar set of conditions allowing for domination of corn. A researcher said at a field day, “It’s agriculture, not alchemy,” suggesting this system was knowable. And it certainly is. But perhaps too we need some magical thinking, some fantasy scapes, to move us outside the system to see it as a multiplicity. Often it seemed everyone had a “silver bullet” that would solve the problem facing Iowa, and I found mine, too. Like Art Cullen, I would hope my “silver bullet” is actually the whole picture, but certainly someone could come along and find the gaps and weaknesses in it, too. From my research, the problem reduced down in its essence to this: the landscape was not slow enough for liveliness and therefore well-being to flourish for all entities. I remember what a conservation expert, Russell, said at a conservation meeting, saying Aldo Leopold asked in his writing, who did we include in our circle of ethics? Could we include trees? Russell then asked, could we include rivers, too? Once we hold the complexity of those conditions fully and honestly, we have generated knowledge and practices that, if circulated well, can aid the change we desire, of prosperous and lively working landscapes, good for people, plants, soil, and rivers.

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APPENDIX A

INTERVIEW GUIDE FOR FARMERS

- 1.a. I'm interested in hearing about your farming history. How did you start farming?
How has your operation changed since then?
- b. Would your family like to take over the farm?
2. What are the most pressing issues facing agriculture in Iowa?
3. Are there things you'd like to see more of in farming, that are happening now or you believe should? [Practices, adoption of technologies or different methods either by farmers themselves or groups related to agriculture?]
- 4a. What do you think about some of current efforts to address nutrient reduction?
- the NRS watershed projects (WQI dems, WMAs) soil health
- b. What will encourage or help people to participate in these efforts?
- c. How are politics affecting the issue? What would you have liked to see happen in the legislative session regarding water quality funding?
5. Have you participated in NRCS or SWCD (or other) projects that promote conservation practices? What was your experience?
6. What are your thoughts about the Des Moines Water Works lawsuit? What are your concerns with regulation?
- How would one size fits all regulation look?
- Would there be any benefits to regulation?
- t-p and accountability?
- b. Do you talk to other farmers about the lawsuit? What do they think? Do you talk to other people (conservation people) about it?
- c. Who do you think farmers trust the most? Distrust?
- Why do many farmers distrust the government?

Specific questions

1. What are your thoughts on
 - a. cover crops?
 - b. third rotations?
 - c. prairie strips in fields?

- d. saturated buffers
- e. bioreactors?

f. other conservation practices you find interesting? problematic? (no/strip till?)

2. Have you heard about the natural nitrogen bank? What have you heard about it?

Demographic Information

Age:

Counties farmed in:

Marital status:

Do you have children?:

Did you go to college?:

Farming Operation Information

Crops (specialty?):

Livestock:

Rotation:

Tillage system:

Acres farmed:

Acres owned:

Do you or your spouse have an off-farm job?:

Do you have employees? Seasonal, PT, and/or FT?:

Are you a member of any farm groups?

APPENDIX B

INTERVIEW GUIDE FOR CONSERVATION EXPERTS

Work history and experiences

1. a. Could you tell me how you started working for this organization? What does your job entail?
b. why did you want to work for this organization?
2. a. Could you tell me how your organization/project fits into the current conversation on conservation, water quality/nutrient reduction, and agriculture?
b. How would you describe the organization's approach to addressing the issue?
c. What does the organization identify as the main issues?
- d. Who are the people you feel the most responsibility to with your work? Whose support do you need most to do your job? Name three.
3. What do you think are some of the best agricultural practices? What would be the best things to do for Iowa's landscape in general?
- 4a. What do you think about some of current efforts to address nutrient reduction?
- the NRS watershed projects (WQI dems, WMAs) soil health
b. What will encourage or help people to participate in these efforts?
c. How are politics affecting the issue? What would you have liked to see happen in the legislative session regarding water quality funding?
5. a. What are your thoughts about the Des Moines Water Works lawsuit?
b. Do you talk to other farmers about the lawsuit? What do they think? Do you talk to other people (conservation people) about it?
c. Why do you think farmers and others oppose regulation?

Specific questions

1. What are your thoughts on
 - a. cover crops?
 - b. third rotations?
 - c. prairie strips in fields?

- d. saturated buffers
- e. bioreactors?

f. other conservation practices you find interesting? problematic? (no /strip till?)

2. Have you heard about the natural nitrogen bank? What have you heard about it?

Demographic Information

Age:

County of residence:

Marital status:

Do you have children?:

Did you go to college?:

Are you a member of any environmental groups? Any farm groups?

APPENDIX C

INVITATION LETTER

Dear

My name is Bri Farber. I am a PhD student in Anthropology at the University of South Carolina. For my dissertation research, I'm doing a project about farming and environmental issues, and I'd like to invite you to participate.

I am trying to figure out what people think the most pressing issues in farming are, how some of these relate to conservation efforts, and how people in Iowa are addressing these issues.

If you agree to participate, I will ask you to meet with me for an hour or two for an interview; allow me to attend organizational events; and/or shadow your work day and activities. Specifically, we will discuss topics like your farming/work history and activities; changes, problems, and successes in farming; and current events related to agriculture and conservation.

You don't have to answer any questions you do not wish to. I would like to record the interview so that I can remember everything we talk about. If that makes you uncomfortable, please let me know and I can turn the recorder off at any time, or not use it if you prefer. If you agree to let me use the recorder, I will keep the recordings private, and no one else will hear them.

I may publish or talk about the results of this study, but I will not reveal the identity of anyone I talk to.

You can drop out of the study at any time.

If you have any questions or problems regarding my study, you may contact me at [phone number] or [email] or my faculty advisor, Dr. Jennifer Reynolds at [phone number] or [email] if you have study related questions or problems. You may also contact the Office of Research Compliance at the University of South Carolina at [phone number].

Thank you,
Bri Farber
[phone number]
[email]

APPENDIX D

PAIRED COMPARISON SURVEY

I'm an anthropology PhD student studying Iowa agriculture and water. I've developed these 20 questions from conversations with farmers, watershed coordinators, public officials and others. This survey should take you 10-20 minutes. There are no right or wrong answers, just what is most important to you. You do not have to answer any question you do not wish to. This survey is anonymous. If you have questions, please contact me at [phone number] or [email]. Thank you for helping my research, Bri Farber

Age:

Sex:

Occupation:

County where you live:

If you farm, how many acres do you own/farm? Own: Farm:

Each question has three sets of choices. Please mark the one thing in each pair of choices that you think is the most important or most true. Some of the choices will be similar, but this will help me learn whether people agree on these things and how important they are to them.

Example: In my opinion, Iowa is the state with

<input type="checkbox"/> really nice people	or	<input type="checkbox"/> fertile soil
<input type="checkbox"/> fertile soil	or	<input type="checkbox"/> the best state fair
<input type="checkbox"/> the best state fair	or	<input type="checkbox"/> really nice people

1. Water quality in Iowa is

<input type="checkbox"/> improving	or	<input type="checkbox"/> worsening.
<input type="checkbox"/> improving	or	<input type="checkbox"/> staying about the same.
<input type="checkbox"/> worsening	or	<input type="checkbox"/> staying about the same.

2. Which of these options causes the most problems for water quality?

<input type="checkbox"/> Farm practices	or	<input type="checkbox"/> naturally occurring nitrogen in the soil
<input type="checkbox"/> Naturally occurring nitrogen in the soil	or	<input type="checkbox"/> urban development
<input type="checkbox"/> Urban development	or	<input type="checkbox"/> farm practices

3. The biggest problem caused by too many nutrients in water is

problems in rivers and the Gulf of Mexico **or** increased cancer rates in Iowa
increased cancer rates in Iowa **or** meeting drinking water standards
meeting drinking water standards **or** problems in rivers and the Gulf of Mexico

4. If water quality were regulated in Iowa, which agency* would be the best regulator?

DNR **or** EPA
EPA **or** NRCS
NRCS **or** DNR

* (DNR: Department of Natural Resources, EPA: Environmental Protection Agency, NRCS: Natural Resources Conservation Service)

5. What should programs focus on for improving water quality?

Implementation of conservation practices **or** education and outreach
Education and outreach **or** water quality measurement
Water quality measurement **or** implementation of conservation practices

6. Of these groups,* the group that can address water quality best is

NRCS **or** producer associations
Producer associations **or** agricultural industry experts
Agricultural industry experts **or** NRCS

* (Producer associations examples: Iowa Soybean Association, Iowa Corn Growers Association;
Agricultural industry expert example: Pioneer agronomist)

7. Who is ultimately most responsible for ensuring clean water in Iowa?

State agencies **or** individual citizens
Individual citizens **or** the federal government
The federal government **or** state agencies

8. What would improve water quality programs?

More cost-share **or** more regulation
More education and research **or** more cost-share
More regulation **or** more education and research

9. The Des Moines Water Works lawsuit is

necessary **or** the wrong approach.
not enough **or** necessary.
not enough **or** the wrong approach.

10. Water quality should be achieved mainly by

in-field practices	or	edge of field structures
edge of field structures	or	stream restoration
in-field practices	or	stream restoration

11. Regulation for nutrient reduction/water quality would

be an economic burden	or	make it fair for all farmers
make it fair for all farmers	or	be unsuccessful
be unsuccessful	or	be an economic burden

12. Iowa's landscape needs more

Perennial vegetation	or	cover crops
Cover crops	or	bioreactors
Bioreactors	or	perennial vegetation

13. Nutrient loss into waterways is the result of

Too much fertilizer	or	bare ground
Bare ground	or	the natural nitrogen cycle
The natural nitrogen cycle	or	too much fertilizer

14. Of these options, the most promising thing in agriculture is

New equipment	or	new hybrid seeds
New hybrid seeds	or	scientific information on different practices
Scientific information on different practices	or	new equipment

15. The most important reason for farmers is to improve water quality is

it's the right thing to do	or	it will keep regulation off farms
it will keep regulation off farms	or	it will have other benefits, like soil health
it will have other benefits, like soil health	or	it's the right thing to do

16. Consolidation of agricultural land

is inevitable	or	needs to be stopped.
needs to be stopped	or	will increase efficiency.
will increase efficiency	or	is inevitable.

17. Which of these options would conserve natural resources on farms best?

A required water quality plan	or	restrictions on fertilizer application
Restrictions on fertilizer application	or	voluntary participation
Voluntary participation	or	a required water quality plan

18. A major problem with the water quality of streams and rivers has been

Weather	or	tiling
Tiling	or	loss of prairie
Loss of prairie	or	weather

19. Of these options, I think farmers feel the most concern about

farm/land transfer	or	the market
environmental regulation	or	farm/land transfer
the market	or	environmental regulation.

20. Iowa agriculture should focus on

producing the highest yields possible	or	improving soil quality
improving water quality	or	producing the highest yields possible
improving soil quality	or	improving water quality

Are there questions I should have asked? Are there categories you believe were missing or more appropriate? I appreciate any suggestions.

APPENDIX E

NO PLANTS, NO PEOPLE

Table E.1: No Plants, No People

Date	Spokesman Author	Headline and Excerpt	Notes
12/14/15	Dirck Steimel, News Service Manager	<p>“Study shows Raccoon River nitrate levels trending lower”</p> <p>The scientific study shows... unpredictable weather and <u>natural levels of nitrogen in Iowa’s rich soils</u> act as the primary drivers of nitrate levels in water in the Raccoon River, said Roger Wolf, ISA’s director of environmental programs.</p>	13 paragraphs later, <u>Castellano</u> , microbes, and plant roots introduced
12/22/15	Zach Bader, Online Community Manager	<p>“Water quality experts: Farmers are cooperating, even when nature doesn’t”</p> <p><u>Weather</u> causes <u>nitrate</u>s to seep from <u>Iowa’s naturally nitrogen-rich soils</u>, and it’s the primary cause of the state’s water quality issues. That’s not me talking. That’s <u>Iowa State University soil scientist Michael Castellano</u> and scientific data that’s been collected for years.</p> <p>According to <u>Castellano</u>, “fertilizer applications really have very little to do with [Iowa’s water quality issues].”</p>	Posted to Farm Fresh Blog

Date	Spokesman Author	Headline and Excerpt	Notes
12/30/15	Dirck Steimel	<p>“Water Quality Myth Busting”</p> <p>“<u>Natural loss of nitrate</u> is really the main thing that is causing us to lose nutrients into our waterways,” <u>Castellano</u> said. “Fertilizer applications really have very little to do with it.”</p> <p><u>Iowa’s deep, black soils</u> have some 10,000 pounds of nitrogen per acre stored in organic matter, the ISU associate professor said...</p> <p>Nutrient losses typically occur in the early spring and late fall, when <u>microbes</u> help to unlock a portion of that natural nitrogen but there are <u>no crops</u> on the fields to take it up, <u>Castellano</u> said.</p>	
3/16/16	Dirck Steimel	<p>“DM Water Works lawsuit <u>misdirected</u>, will slow progress.”</p> <p>Hill noted that <u>research at Iowa State University</u> and other institutions shows that nitrate levels in Iowa rivers are heavily influenced by weather as it interacts with naturally occurring nitrates in the state’s rich, black soils. <u>Farmer practices</u>, such as applying <u>fertilizer</u> to grow corn, have little influence on the amount of nitrates in streams and actually help reduce nutrient loss by <u>increasing crop yields</u>, he said.</p>	Craig Hill is the IFBF President.
3/28/16	Dirck Steimel	<p>“Measuring Iowa’s march to reaching water quality goals”</p> <p>In addition, <u>Iowa’s famous deep, black soils</u> are naturally very high in nitrogen and farmers’ practices are only a piece of what causes nitrogen to end up in the streams and rivers.</p>	Subheading: Collecting data Also unclear if quoting John Lawrence or not—quoted in paragraphs bracketing this one

Table E.1 No Plants, No People (cont.)

Date	Spokesman Author	Headline and Excerpt	Notes
4/21/16	Laurie Johns, Public Relations Manager	<p>“Seven new videos demonstrate top ways farmers protect Iowans from nitrates in the water”</p> <p>Iowa’s increasingly tumultuous weather, varied terrain and <u>globally-recognized</u> fertile soils contribute to the challenge of keeping nitrates in the soil, where they naturally exist at a greater level than nearly anywhere else in the world .</p>	Links to webinar by <u>Castellano</u>
7/24/17	Tom Block, News Coordinator	<p>“Duvall gets up close look at Iowa conservation efforts”</p> <p>The prairie, which has never been touched by a plow, shows the <u>naturally-occurring high organic matter</u> present in north-central Iowa soils, [Brent] Johnson said. Soil tests show nitrate levels of about 7,100 pounds per acre in the prairie, which is almost twice as high as a sample taken from a nearby crop field, he said. The <u>naturally-occurring</u> nitrate makes the region’s soils among the most productive in the world, but also contributes to water quality challenges, Johnson pointed out.</p>	Brent Johnson is a director of a local IFBF chapter.
Undated (6/30/16?)	Progress report	<p>“Iowa conservation progress and future challenges overview”</p> <p>Iowans concerned about their drinking water should know that nitrates are naturally <u>occurring</u>, anywhere there’s soil. In Iowa, nitrogen is especially abundant in soil, making it rich and fertile for growing crops.</p> <p>The primary reason for nitrate loss is not the mismanagement of nitrogen fertilizer or farmer behavior, according to Iowa State University. <u>Most nitrate loss to Iowa streams is caused by mismatched timing between the uptake of nitrate by growing crops and the natural microbial production of nitrate</u> from nitrogen found in native soil organic matter.</p>	